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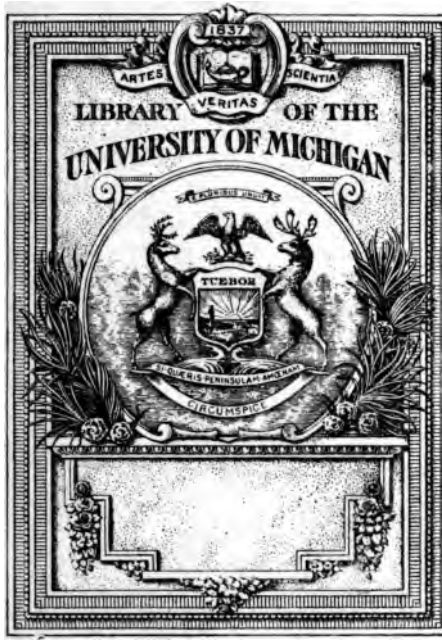
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PRODUCTION RECORDS

How the Factory Keeps Account of the Elements Entering into Production

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Being the Fifth Unit of a Course in Modern Production Methods

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BUSINESS TRAINING CORPORATION
NEW YORK CITY

Course in Modern Production Methods

JOHN CALDER, Director

With the assistance and cooperation of

FRED H. COLVIN
ARTHUR C. JEWETT
JOHN A. HARTNEDY
J. WILLIAM SCHULZE
JOHN H. VAN DEVENTER

The text of the Course is issued in six units as follows:

I. Teamwork
II. Handling Men
III. Organization
IV. Machinery and Materials
V. Production Records
VI. Management

BUSINESS TRAINING CORPORATION
NEW YORK CITY

TABLE OF CONTENTS

Chart, Compass, Barometer

THE modern factory may be likened to a steamship. Just as the ship has its captain, underofficers and crew, the factory has its manager or superintendent, foremen and workmen. Just as the ship has its engine room and propeller system, the factory has its mechanical equipment. Just as the ship has its necessary store of supplies, the factory has its raw materials.

There is still a fourth point of similarity. The ship has its chart, compass, barometer. Without these it would be simply a drifter, dependent upon every whim of the sea and every change of the weather. The factory has its system of records, without which it would be as helpless and uncertain as a pilotless ship.

The records guard the assets of the factory; they sound the danger signals against carelessness and waste. The records tell what has been done, and thus provide a basis for planning future work. They show where losses are occurring and where profits are being made. They expose idleness; they reveal productiveness. They substitute exactitude for guesswork. Records make it possible for factory teamwork to move along steadily toward the port of 100 per cent productive efficiency.

I

Why Keep Records?

JOHN ROSWELL, president and principal owner of the Roswell Manufacturing Company, returned from his trip East in high spirits. And no wonder. For he brought back the fruits of victory. He had gone after a certain contract, in a territory that was absolutely new to him; and in competition with a dozen rivals, every one of them a well-known manufacturer in his line, he had got the contract. As the treasurer said, congratulating him, "It was a killing."

"Well," explained the president, "it was our prices that did it. We've simply got the jump on these other factories, somehow. I didn't cut down a single figure. I didn't change any of the estimates we agreed on here in the office before I left. I didn't have to. Our quotations were a good margin below even those big New England fellows whom we feared most. And this is the result." Roswell took the written contract from his pocket and handed it to the treasurer.

Outbidding Competitors

The order was a fairly large one, and a

good profit had been figured on it. But it was not so much the size of the business, as the fact that it was new business, that caused elation. Heretofore the Roswell Company had taken on only an occasional special contract. Its manufacturing was principally manufacturing for stock, and it confined its selling activities largely to the Mid-Western territory in which it was located. As a matter of fact, Roswell products were so well known and highly esteemed in that section, that rival manufacturers found it almost impossible to make much headway against them. But now the Roswell Company had decided to go into outside territory, and extend its business beyond the limits of its own section. The opportunity to bid on a job for an Eastern buyer had come, and had been grasped as a chance to break into the national field. Conferences with the various production foremen had been held, estimates had been made, prices had been agreed upon, and armed with these figures the president had made his trip East—with results as reported.

The order was turned over to the production departments of the company, and during the next four months John Roswell made more trips and came back with more orders. Business was booming. Production was coming along swimmingly, according to oral

reports from the various foremen. But the contract on that Eastern order called for delivery within six months, and as only two months remained, Roswell decided one day to go through the plant and personally check up its progress.

Letting an Order Take Care of Itself

It was good that he did, though what he discovered made his heart sick. He found that far from being in "apple-pie order," as Jim, the foreman of one of the departments had reported to him only that morning, the job was in a horrible mess. Jim's part of it, to be sure, was in apple-pie order; the production through his department was right up to the schedule that Jim had set for himself. But in another department the production was far behind; and when the situation was called to the attention of the foreman there, it was discovered that his men had been switched to another job because certain raw materials needed for the prior job had not been received. This carried the investigation to the stores department, and there it was found that the stores clerk had mistakenly given out for another job material which was supposed to be reserved for this one.

By dint of much telegraphing and the shipment of material at costly express rates, the shortage was made good within a few days.

And by concentrating all needed forces on the delayed job, its production was shoved through so that delivery was made on the last day of the six months allowed by the contract. Of course the speeding-up process was expensive, and money was lost on the job where profits had been expected. But the reputation of the company was saved. Moreover, as Roswell some months later remarked, "that little set-to was a valuable lesson and worth all that it cost."

It taught the Roswell Manufacturing Company the importance of adequate records. The failure of the stores clerk was due to the failure of his records to show what materials were to be reserved for each job, and how much, and when they would be needed. As a matter of fact, the stores clerk had largely depended on his memory to keep tab on these things. It had been a point with Roswell "to waste as little time as possible on paper." Card systems and files and "all such truck" had been only tolerated. Where used at all, they were regarded as necessary evils, and were used as little as possible. Not only the stores, but other departments as well, reflected this attitude of the president.

A Failure of Records

But the costly experience with that special order—that contract which had been hailed

as the beginning of big things—woke Roswell up, and he decided to give his business a thorough inspection. He had always been scrupulously careful of equipment; machinery in his plant was subjected to regular inspection, and repairs were made promptly. But the inspection which he now proposed was to be of a different kind. It was to be an investigation of methods, rather than of equipment; and in order to make it as unbiased and as thorough as possible, he decided to call in an outsider.

Calling in the Business Doctor

This outsider, an expert production engineer and systematizer, came into the offices and plant of the Roswell Manufacturing Company in much the same way that a doctor goes into a sick room. He was called in to diagnose the case and prescribe a remedy. John Roswell gave him the run of the place. All the books were turned over to the investigator, and he spent several days analyzing them. Then he spent another week in the plant, visiting the various departments, studying the methods employed in carrying through the production, in keeping account of material, of labor, and of other costs, and of caring for the finished stock.

The results of this investigation were summed up in a written report in which the

investigator showed these startling facts:

1. The cost figures upon which the bid for the Eastern contract had been based, were inaccurate. The foremen had no exact records of production costs, and as a result their estimates were little more than guesses. It was shown that even had there been no extra expense caused by the shortage of material, the company would have lost money on the contract.

2. There was no system for reporting the progress of work through the plant, and as a result some departments were frequently overcrowded with work while others were running light. Consequently there was considerable loss in idle machinery and labor, as well as in power and other overhead.

3. Material used was far in excess of what the output warranted. This was accounted for by loose checking of raw material as delivered, by wasteful issuance of material from stores, and by spoilage of work in process. There were no records to show up these leaks as they occurred.

It may seem incredible to a modern factory man that a plant could be operating for years, apparently successfully, with such loose control of the elements entering into cost. But the case is an actual one, though of course the *names are* camouflaged. The luck of an early

start and an exclusive sales territory had made the business profitable in spite of these heavy drains upon it. Production moved along through the factory largely of its own momentum. Goods were turned out for stock and then were sold at such prices as conditions seemed to justify. It took the big special order, with its race against time, to show how inefficient and wasteful the business really was.

The sequel to this story can be told in a sentence. With the proof of lost profits before him, John Roswell lost no time in installing an adequate system of production records; and now he knows exactly where his money goes; his prices are based on actual costs, and not guesswork; and his production and deliveries are scheduled as carefully and with almost as little error as the course of the Twentieth Century Limited from Chicago to New York.

Good Memory Cannot Take the Place of Records

Some men pride themselves on having a good memory. Such a possession is a real asset, of direct value in business, but a good memory should never be allowed to take the place of records. Records are necessary to reinforce the memory, to take care of details of figures, of dates, of plans *and schedules.* By the use of records

the memory is freed of a great mass of rou and enabled to occupy itself with de which card catalogs and files cannot care Moreover, a good memory is a pers possession, and should the man with good memory die or quit, the mass of d which he carried in his head would go w him.

Some years ago a concern which ma factures metal novelties had its plating a metal-finishing department in charge of chemist who was something of an invent Through a series of experiments this man veloped a chemical process which gave product a beautiful and distinctive color. its advertising, the company featured t exclusive quality of its product and built a considerable reputation for it. In time chemist resigned and left the country, a when his successor attempted to plate product it was found that he was unable duplicate the chemical solution which g the distinctive coloring. None of the men the department seemed to know the ex formula used, and it took a month of expe menting on the part of the new chemist, d ing which production was entirely curtail to hit upon the exact combination desired

The discoverer of the process of course h the formula "in his head." Perhaps he h

a written notation of it among his papers. But the company had failed to provide a system for recording and filing such data, and as a result the new chemist had to make the discovery all over again. Work had to be done twice, not to speak of the loss resulting from the interrupted production, simply because of the lack of a written record.

Records and Planning

Records are necessary to the planning of a job. It is on the basis of what men have previously done with a certain machine or a certain tool, operating upon certain material, that the management is able to schedule work. Were no records kept of past work, it would be impossible to schedule future work with any degree of efficiency. Here it is fatal to trust to the memory of the foreman or other shop executive. There may be here and there a mental prodigy who can remember exactly what output per hour should be made at each machine, who knows to a dot what Jones can do in a given job, and what Smith can do. But these exceptional men are not available in every factory; and moreover their memories (like that of the chemist) may depart with them any day. The only safe way, the only right way, the only business way, is to keep careful records of all elements that enter into production and of all factors that affect the move-

ment of material from its raw state to the finished product.

This does not mean a conglomerate mass of records. There is such a thing as having too many records—of demanding so detailed a system that undue time is spent entering and keeping the records, and the recording activities become a drain and burden upon the business instead of a help. Every extra clerk required for record-keeping, means an extra salary that must be paid out of the production; and unless his work does contribute to efficiency of production, he is a useless cog. Sometimes you will find one man employed keeping records that are already kept by someone else.

Danger of too Many Records

Investigation was recently made of an industrial concern in New York whose production is carried on through twenty operating departments. It was found that each department employed two clerks to keep the time and other job records of the operatives. In addition to these operating departments, however, there was a cost accounting department in which eight clerks were employed doing over again the same sort of thing that the time-recording clerks in the operating departments were doing. The result of the investigation was to *cut out this* needless duplication by elimina

ing the departmental time-recording and centralizing this work in the cost accounting department. Today a simple report of time spent is issued to each department regularly by the cost accountant, and each department has as adequate record as was the case when it was using two clerks to do its own recording.

Records, it must always be remembered, cost money. There is the expense of equipment—printed forms, filing cabinets, and the like; the salaries of those who look after the proper entering and filing of the records; and the floor space occupied by the record-keeping departments. The tendency of the average man in business is to start a new file without stopping to count the cost and to measure the possible benefit with this cost. One purchasing agent kept a file of booklets, simply because he was interested in advertising and thought he would like to have them handy to look over from time to time. He never stopped to think that his file of booklets cost company time and company floor-space without returning anything to the company. It never occurred to him, apparently, that the company's advertising manager had a file of booklets, far more complete and interesting than anything the purchasing agent would gather, and that these might be consulted by

him on applying to the advertising department. Many large concerns have centralized all records under one executive, and before new files may be established or new record-gathering activities put into effect, they must have the O. K. of this official. In a particular instance, such an appointment caused a saving of $20,000 in a single year.

What Records Are Necessary

The way to determine what records are necessary, is to analyze the functions of the business and note what records are needed to keep performance of these functions up to the highest level. There is one function that is universal to all business. It is the function of earning money for its owners—of making a profit. The factory makes a profit by producing goods which will sell at a price greater than the cost of production. It is clear that whatever tends to reduce the cost of production is an advantage to the factory. If its production costs are lowered, it can either earn a larger profit on each finished product it sells, or it can cut its price and so win customers from its competitors and thus earn a larger profit by producing and selling a larger output.

Records are necessary, therefore, which will enable the factory to produce its goods at the lowest possible cost, and which will enable it to fix its selling price with knowl-

edge rather than guesswork. Such records should keep account of

1. Plant and equipment—the original investment, additions made from time to time, depreciation, and other factors affecting value.
2. Purchases.
3. The receiving, storage, and handling of material.
4. Labor.
5. The handling of work through the factory.
6. All indirect expense of production.

When a plant has a system of records which keeps its management accurately informed on these matters, production can be carried forward with confidence. Such a plant is able to give customers definite promises of delivery, for its work moves along according to schedule and it knows just what it can do. It can bid on a contract or name a price without guessing, for it knows its costs. It can take advantage of favorable market conditions to stock its stores room; it can distribute its orders so as to make operations more uniform, and therefore give steady employment to labor; it can keep its plant "up to scratch" and its capital investment unimpaired. The modern manufacturing concern can do these things—if it has adequate records to guide its management.

One important group of factory records not *touched upon* in this Unit is the system of

personnel or employment records. They have been treated in detail in Unit III, and repetition here is unnecessary; but it should be borne in mind throughout how important a factor in plant efficiency the personnel records are. They aid the management directly in fitting men into the work for which the men are best adapted, not to speak of their assistance in reducing labor turnover.

There are four cardinal principles which should be observed in planning and installing record systems. These are:

1. Accuracy.
2. Timeliness.
3. Simplicity.
4. Adequacy.

Four Principles Essential to Good Records

Unless the records are *accurate,* they are not only a waste of the money spent in keeping them but they may also cause other losses through their misleading guidance. The manufacturer of a certain well-known article of small unit value but of wide distribution, discovered some time ago that the cost reports which he received monthly did not tally with the annual statement of profit and loss received from his accounting department. The monthly cost reports showed a cost which would allow a good profit, but the annual statement showed that a much smaller profit

had actually been received. An investigation was made, and it was found that the cost clerk in making up the monthly cost report had failed to check the total labor charges on the job tickets with the total labor charges on the payroll for the same period. He ignored the item of defective work. His reports showed only the cost of articles actually finished. They were inaccurate, in that they failed to show the cost of spoiled material and labor spent upon such work.

Timeliness also is essential. The manufacturer wants to know the standing of work in his production departments this week—so that he may plan operations for next week. He wants to know the cost of production now, so that he may regulate his prices in time to benefit by the knowledge. He wants to know the moment a new order for material must be placed.

The more complex and involved a record is, the greater the expense of it. Complicated records cost time in the making of them, and they also call for an unusual amount of effort and mental concentration on the part of the person consulting them. *Simplicity* is almost as essential as accuracy. And this applies not only to the record itself, but to the method of filing. Where symbols are used they should be such as can readily be remembered.

Finally, the records must be *adequate.* That is to say, they must give all necessary information. This does not mean that everything about the subject must be down on the record card. It does mean that no important question be left unanswered. Abbreviations may be freely used, provided their meaning is clear. It is quite possible, as succeeding chapters will show, for a record to be both brief and adequate.

When Records were Inadequate

A certain stove manufacturer in Pennsylvania had an experience which exemplifies what may happen if the records are inadequate. Four models of stoves were manufactured in his factory. The selling price of each was fixed on the basis of estimated costs, and the manufacturer depended on the financial statements which he received from his accounting department to show whether or not he was making money. Month after month these statements showed a slightly declining profit, but increasing sales. This was rather disturbing. It seemed reasonable to the manufacturer to expect an increase in profit as his sales increased. He had an expert investigation made, and it showed that while he was making money on three stoves, he was losing money on the fourth model. Moreover, this fourth model, because of its cheap

price, was selling in large quantities, thereby increasing the total of sales. Naturally, the more this fourth model sold, the less his monthly profits. Had the monthly statement submitted by the accounting department been itemized to show returns on each model separately, the manufacturer would have seen the situation immediately and taken steps to remedy it.

Good operation and good management are so much a matter of having and following correct records, that the modern factory recognizes the function of record keeping as an essential element in successful production work. Business records are no longer the exclusive concern of some routine bookkeeper or specialized bookkeeping department, but are vital in the shop office and in the operating departments as well as in the executive offices. The following chapters will treat of the various kinds of records which factor in modern production. They will indicate how these records contribute to efficiency—not only safeguarding the welfare of the plant, but also helping the individual worker to make good.

II

Labor Records

PERHAPS the production record with which the factory man comes in contact first is that which keeps account of his work time. Such records are labor records, but since labor is reckoned in terms of minutes or hours or days spent upon a job, the system of keeping labor records has to do first of all with time.

Time is a factor of far-reaching importance in industry. It affects costs. It affects output. It affects profits. Without stated times for beginning work and for quitting work, there can be no effective teamwork, no successful planning of work, no real control of production. Moreover, unless the hours of labor are scrupulously observed, the factory is suffering a money loss just as real as when material is wasted in the shop or when the lights are thoughtlessly left burning all night in the office.

Time as a Factor in Production

Five minutes late in the morning may not seem of any great consequence. But suppose

every man in the plant thought that way and acted accordingly. If five hundred employees were five minutes late one day, the time lost would be equivalent to an entire week of work time of one man. And perhaps the least item of waste would be wages. In addition, there is idle machinery, occupying floor space upon which taxes or rent is paid and representing a money investment upon which interest is paid; the power is on, from which no benefit is derived; overhead expenses of various kinds are going ahead, and production is temporarily suspended. If every man could realize that the time he wastes is cutting down his productiveness—his industrial efficiency—there would be less disregard of the value of five minutes.

The Check System of Keeping Labor Records

Since the time element is so important in factory operation, some system of keeping account of the arrival and departure of employees is necessary. Perhaps the oldest of these systems is that which makes use of the TIME CHECK. This system is variously applied in different plants. In one factory, the workman is given a brass check as he enters the plant in the morning; and on reaching his department he hooks the check upon a checkboard opposite his name. In another plant, the board is placed at the en-

trance, and the employee takes his numbered check from the board as he enters; when the signal for starting work is given the timekeeper notes which checks are still on the board, and records the absences; during working hours each employee keeps his check, hanging it on the board as he passes out at quitting time. Thus, the presence of a check on the board indicates that the workman identified with that check is out. By consulting the checkboard at any time, the timekeeper or foremen can tell who is absent.

Another primitive system of keeping time dispenses with checks altogether. As the workmen enter the plant in the morning, each man calls his number or name, and the timekeeper keeps tabs on his list. For those tardy, the time of arrival is noted. It is then easy to see by the blanks on the list who are absent.

While these systems have proved fairly satisfactory in small plants, they are subject to various criticisms. Checks are easily lost or misplaced. Timekeepers after all are human, and may occasionally make an error in entering a record. Even the most careful will sometimes be accused by a disgruntled offender of "making mistakes." A system that will automatically and by mechanical means make a record of arrivals and departures puts *an end at once* to all such controversies, and

at the same time considerably reduces the expense of timekeeping.

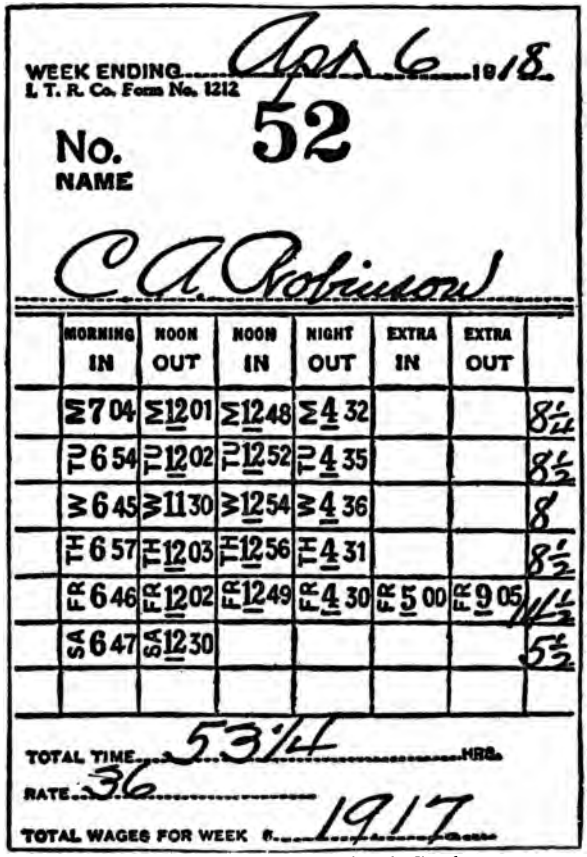
Such a system is provided by the TIME-RECORDING CLOCKS which have come into wide use within the past few years. Each employee records his own time as he enters or leaves. There can be no dispute or difference of opinion as to the accuracy of the record, since it agrees with the time which he reads upon the face of the clock as he registers. Moreover, the record is typed upon the card or tape, and is more legible than the average handwriting.

The Recording Clock

The correct place for the recording clock is within or directly at the entrance to the operating departments—not at the entrance to the plant which may be a full three or five minutes distant from the actual manufacturing. The machinery starts at the opening hour, and the on-time workman should be at his *place* at that hour, not just ringing in at a clock six hundred feet away.

Recording clocks vary in details of operation. Some record the time upon a tape within the clock. Others print the time upon a card. Where clock cards are used, a separate card for each workman bearing his number and name is made out each week. There is a card rack on each side of the clock, one marked "in," the other "out." Each rack

is provided with spaces numbered to correspond with the employees' cards. As a man enters he takes his card from the "out"



WEEK ENDING Apl 6 1918.
I. T. R. Co. Form No. 1212

No. 52
NAME C A Robinson

	MORNING IN	NOON OUT	NOON IN	NIGHT OUT	EXTRA IN	EXTRA OUT	
	M 7 04	M 12 01	M 12 48	M 4 32			8 1/4
	TU 6 54	TU 12 02	TU 12 52	TU 4 35			8 1/2
	W 6 45	W 11 30	W 12 54	W 4 36			8
	TH 6 57	TH 12 03	TH 12 56	TH 4 31			8 1/2
	FR 6 46	FR 12 02	FR 12 49	FR 4 30	FR 5 00	FR 9 05	11 1/2
	SA 6 47	SA 12 30					5 1/2

TOTAL TIME 53 1/4 HRS.
RATE .36
TOTAL WAGES FOR WEEK $ 19.17

A Familiar Form of Clock Card

rack, inserts it in the slot in the clock, and pulls down the handle, thus printing the time *upon the card* in the column headed "morn-

ing-in" or "noon-in" as the case may be. The card is then placed in the "in" rack. Upon leaving the process is reversed, the time of departure is printed in the column headed "noon-out" or "night-out," and the card is dropped in the "out" rack. In some forms of clock, early departures and late arrivals are printed in red, thus making them recognizable at a glance.

The foreman need only look at the "out" rack to see who are absent. At the end of the week the card contains a printed record of the employee's attendance. When all late coming and early going are stamped in red, irregularities are prominently indicated. The number of hours at work each day are entered in the total column and by adding these up it is easy to compute what wages are due for the week. In some factories the clock card has a coupon attached upon which a form of receipt for wages is printed; when the employee receives his wages he signs this form and leaves it with the payclerk or cashier.

The electric clock has certain advantages not found in the spring-wind clock, and is especially adaptable to large plants, whose requirements demand a large installation to serve many departments. In an electric system, the *entire* equipment is controlled by

a master clock usually to be found in the office of the works manager. Besides insuring absolute uniformity in time recording, the system automatically sounds the bells in all departments at starting and quitting time.

However, the clock or tape is a limited record. It tells absences and tardiness, and the number of hours spent within the plant; but it does not show how much of this time is spent in actual work.

Recording the Time Spent

It is important for many reasons that the factory management have an account of how its workmen *use* their work time. It is important to know, for one thing, how much of the time spent within the factory is really productive. Secondly, knowledge of how much time has been spent upon a job guides the management in future planning and scheduling of similar work. A third reason for accurate records of how work time is used is found in the cost records; unless it is known how much of each employee's time was spent upon one job or upon a given amount of production, it is impossible to charge up a proper proportion of his wages against that production. Even where the workman is paid upon a piecerate basis, the time spent upon the job is an important item to the cost department since it may indicate how to apportion the overhead ex-

penses—light, heat, taxes, rent, cost of administration, and the like.

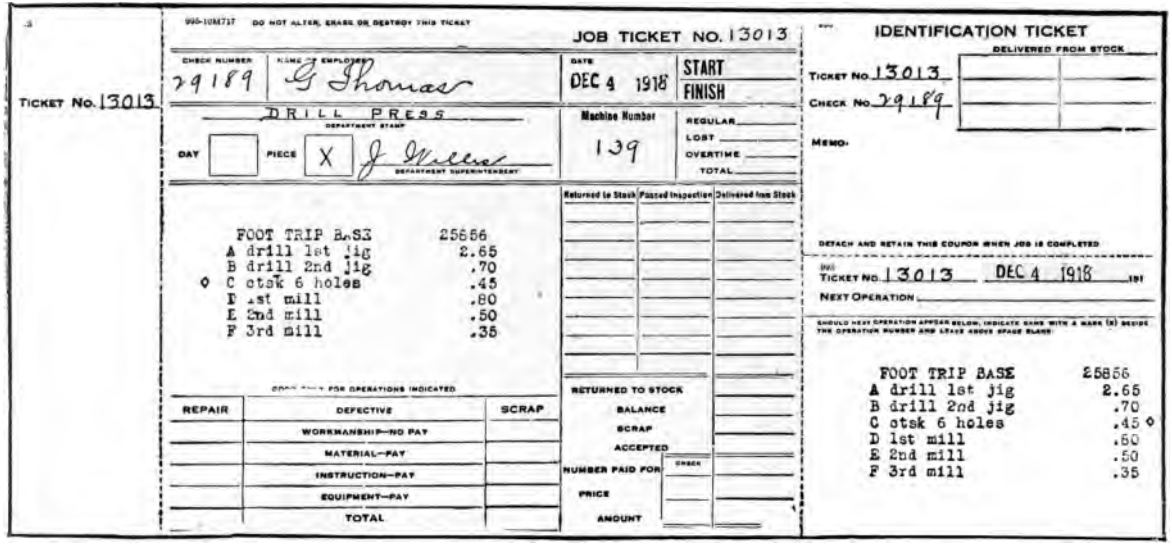
Various schemes have been used to keep tabs on time within the operating departments. In some, the workman simply tells the timekeeper how long the job has required, and the timekeeper notes this oral report on his time sheet. In other systems the workman makes out a written report at the end of the day or upon completion of the job, indicating how his time has been used. Such methods of keeping records are inefficient, except in rare cases. Too much is left to the memory, and recording the use of time after the work has been completed is too often a matter of guesswork. Where the workman himself is left to fill out his time slips, there is a natural temptation to make as good a showing as possible. If some of the jobs took longer than conditions would seem to warrant, there is the temptation to change this appearance by balancing the time more evenly among the various jobs. Such a practise defeats one of the main purposes of the records—namely, to ascertain the labor cost of each unit of production.

Such a practise, moreover, works to the injury of the operative himself. Suppose, for example, a certain reaming operation required more time than the operative thought

it should, whereas other reaming, because of the simplicity of the operation, was done in exceptionally good time. By "fixing" his work reports so that the simple operation was shown to have required slightly more time than it actually did, and the difficult operation slightly less, the workman might seem to make a better showing. But if later he were assigned a big job of the difficult reaming to do, and were expected to finish it on the basis of the record he had previously reported, you can see where he would come out. There would now be no chance to even up a lean job by borrowing from a fat one, because in this case the whole job would be lean. Absolute honesty in making records is essential to accuracy, and to efficiency.

Leaving Time-Recording to the Workman

The way to safeguard the accuracy of time records is to take the responsibility for recording them out of the hands of the operatives. This is no reflection upon the workman, but is simply an application of the principle of specialization. Relieved of responsibility for keeping tally on his time, the workman can concentrate upon his job and thus make the fullest use of his time. Moreover, one central authority in the department or work room is held accountable for the accuracy of



TICKET No. 13013

990-10M717 DO NOT ALTER, ERASE OR DESTROY THIS TICKET

JOB TICKET NO. 13013

CHECK NUMBER 29189 NAME OF EMPLOYEE G Thomas

DATE DEC 4 1918 START FINISH

DRILL PRESS DEPARTMENT STAMP

DAY PIECE X J Miller DEPARTMENT SUPERINTENDENT

Machine Number 139

REGULAR LOST OVERTIME TOTAL

FOOT TRIP BASE	25856
A drill 1st jig	2.65
B drill 2nd jig	.70
◊ C otsk 6 holes	.45
D 1st mill	.80
E 2nd mill	.50
F 3rd mill	.35

Returned to Stock	Passed Inspection	Delivered from Stock

CODE NUMBERS FOR OPERATIONS INDICATED

REPAIR	DEFECTIVE	SCRAP
	WORKMANSHIP—NO PAY	
	MATERIAL—PAY	
	INSTRUCTION—PAY	
	EQUIPMENT—PAY	
	TOTAL	

RETURNED TO STOCK
BALANCE
SCRAP
ACCEPTED
NUMBER PAID FOR CHECK
PRICE
AMOUNT

IDENTIFICATION TICKET

DELIVERED FROM STOCK

TICKET No. 13013
CHECK No. 29189
MEMO.

DETACH AND RETAIN THIS COUPON WHEN JOB IS COMPLETED

TICKET No. 13013 DEC 4 1918

NEXT OPERATION

SHOULD NEXT OPERATION APPEAR BELOW, INDICATE SAME WITH A MARK (X) BESIDE THE OPERATION NUMBER AND LEAVE ABOVE SPACE BLANK

FOOT TRIP BASE	25856
A drill 1st jig	2.65
B drill 2nd jig	.70
C otsk 6 holes	.45 ◊
D 1st mill	.80
E 2nd mill	.50
F 3rd mill	.35

FIG. 1.—Job Ticket used by a large Eastern Factory

all time records, and this fixing of responsibility is a further gain in efficiency.

The job-ticket system is used by many modern plants in recording work time. For each job assigned to a workman a JOB TICKET is made out by the foreman, or by a clerk in the shop office, indicating the nature of the operations to be performed, material to be used, and giving other instructions. When the work is given out, the time is stamped upon this ticket; and when the work is returned completed, the return time is similarly stamped. Thus, the job ticket shows on its face an exact record of when the work was started and when it was completed, and the calculation of time spent is a simple matter.

Using the Job Ticket

The job ticket of a large Eastern factory is shown in Figure 1. This ticket was carefully planned to insure accuracy and reduce clerical work. It will be noticed that practically all instructions and records on the ticket are printed, the only handwriting being the check number and employee's name and a cross to indicate whether time work or piece work. The printing of the part name and number and the list of operations is done by means of an addressograph machine. A stenciled plate is prepared for each job in advance, and to make up a job ticket it is neces-

sary only to take the proper plate out of the file, fix it in the machine, and a slight pressure prints the matter upon the ticket. A hand punch is used to indicate the operations to be performed.

After the ticket is made out, it goes to the stock clerk, who issues the necessary material and stamps upon the ticket a record of the quantity issued. When the operative is ready to receive the work the starting time is stamped upon the ticket and the ticket is delivered to him with the material. It is important to bear in mind here that in many modern manufacturing plants the job tickets are prepared considerably in advance, and the necessary tools and materials are got ready in advance. When the work is finished, the operative detaches and retains the upper coupon as his receipt, and the work is returned to the stock room. With it goes the ticket, including the lower coupon. In the stock room the finishing time is stamped upon the ticket, the job is inspected and such work as may be defective is taken out and a record of it entered upon the job ticket. The stock clerk then counts the good parts, stamps the quantity of good parts upon both the ticket and the coupon. The coupon is attached to the good parts, and serves as a guide to the next operation. It indicates what operation is next to

be performed as well as the number of parts in the lot, thus making it unnecessary to recount the lot when giving it out for the next operation. The job ticket goes to the accounting department and becomes a record to assist in making up the payroll and for determining costs.

This system was made to suit the needs of a single large industry. In details it may vary from other systems in use, but the principle of specialized record-keeping is followed here as it is in all modern systems.

Idleness between Jobs

One waste which exact time records tend to eliminate is lost time between jobs. The job ticket shows up in unmistakable figures *when* the work was issued and *when* it was returned, and there is no chance of concealing idle moments between jobs.

In one plant of considerable size the men themselves called attention to a time-wasting practise which was hurting both employer and employee. The workmen in this plant were required to call at the store room for material and secure tools from the tool room, as well as return finished stock and tools at the completion of the job. It was nothing unusual to see half a dozen men awaiting their turn at the store room. The shop was operated on a piecerate basis, and there were many

complaints from the workmen who chafed under this idleness and the curtailed earnings which it involved.

If you pass through that plant today you will find a new system in operation. The men are at their machines. They are no longer permitted near the store room. You will notice at convenient positions throughout the shop boxes with transparent sides of glass so that the contents are readily visible. Beside each box is a check board marked "Work-Wanted Cards"; on the board are hooks bearing cards upon which are the check numbers and names of the operators in that section. When a workman gets within fifteen minutes of the completion of his job he takes his card from the board and drops it in the box, returning immediately to his machine. A floor messenger, who is constantly on the lookout for such cards, sees it in the transparent box, takes it out and delivers it to the foreman. That card tells the foreman that the workman whose name and number are stamped thereon will finish his job within fifteen minutes. So he assigns him a new job. The clerk makes out a job ticket, sending it to the store room where the necessary material is made ready; the necessary tools also are issued. All are delivered by the floor messenger to the operator, *usually* reaching him a few minutes before

the old job is finished. As soon as the old job has been collected and delivered to the stock room the work-wanted card is replaced on the board.

This scheme has proven wonderfully successful. It has materially increased production by permitting the producer to stick to his machine. As a refinement upon the original idea, floor wagons fitted with shelves are used by the messenger to deliver the new work and return the old. With these wagons it is possible to carry as many as a dozen jobs in either direction. One floor wagon can easily attend to seventy-five men.

Complaints are no longer heard. Production has been increased. The interests both of employer and of employee have been bettered. And incidentally it was one of the workmen who thought of this scheme and suggested it to his foreman—with results as described. That keen-sighted workman was generously rewarded by the company for his initiative and clear thinking.

In many factories, the planning and scheduling of work is so carefully calculated that the foreman has the next job ready by the time the workman is finishing the present one. Operations are standardized, there are exact records of how long each job should take, *and by* dispatching the work upon these

records the orders or jobs in each department move forward like clockwork. The use of production orders in this connection is discussed in Chapter VI.

Time Records Help Both Employer and Employee

Looked at from the right angle, all time records are an advantage and help not only to the management but also to the men themselves. Idleness doesn't profit anybody—not even the fellow who practises it in day work and is able to fool the boss. Such a man is simply building up habits which will eventually ruin him for any position in business. He is earning a bad reputation and losing the respect of his fellow workmen. He may be joshed and joked about "taking it easy" and "getting away with it," but eventually he will be found out, and eventually he will discover that the joshing is not unmixed with a flavor of disgust. First-class workmen have little respect for the wilful habitual idler.

On the other hand, the workman who is painstaking in his use of time, who is eager to make the best possible showing, is the workman who regularly gets wage increases and promotions. Any system which helps a man —be he operative, foreman, or superintendent —to safeguard his minutes from idleness or *other waste, is* helping him to upbuild habits

of industry and to make himself felt. A vital element in production efficiency is time. The good productive man is essentially a time saver.

III

Purchase Records

WHEN the report of earnings for the preceding year was made known to the directors of a shoe manufacturing company at their first meeting of the new year, there was a general feeling of satisfaction. Notwithstanding higher costs, due to increases in practically every item entering into the cost of production, the sales had been greater and the margin of profit higher than that of any previous year. It seemed altogether appropriate, therefore, to pass a vote of thanks expressing the company's appreciation of the efforts of the man who had brought in this big business—the sales manager. He was the recipient of many congratulations and words of warm appreciation from every member of the board.

Where do Profits Come from?

One of the directors, while pleased, was nevertheless puzzled. He was also a stockholder in another shoe company. Its sales had been even greater; its sales manager was considered one of the biggest men in his line; yet the profits for this company showed a decrease

from those of the preceding year. Was it, after all, the sales that were responsible for the results? Here was something worth investigating, and in a quiet way the director undertook an investigation on his own account.

He found that selling expenses in both companies were normal. Expenses of administration were about the same. Costs of labor fairly balanced, labor conditions being practically equal. Between the two plants, there was no important difference in operating costs. Finally the search narrowed down to a comparison of the methods of purchasing raw material and supplies used by the two plants, and here the search ended. For here, indeed, was the leak.

While one company had systematized its purchasing function and developed it to a point where purchasing was a factor in the profits and played almost as prominent a part as the sales, the other, not realizing the importance of this function, had been content to leave it to different executives each of whom was responsible for purchases in his department. Since purchasing was only a small part of their responsibilities, they naturally looked upon it as of minor importance; and the result was not only duplication of effort but careless and unskilled buying.

The result of this director's inquisitiveness was a complete reorganization of the purchasing function in the second company. A purchasing department was created, and all responsibility for purchasing was centered in this new department. At the same time the director took pains to call the attention of his associates on the board of directors of the other company to this situation, and to suggest that perhaps their company's purchasing department was quite as deserving of congratulations as its sales department. In fact, he pointed out that success was due to the united work of all departments—administrative, producing, and sales. It is not brilliant effort on the part of one department that wins profits, but the steadfast efficient cooperation of all departments pulling together.

Teamwork of All Departments Necessary

Purchasing is one of the functions that seem to have little interest to many men in production work. They think of their responsibility as confined entirely to the actual processing, and any little leaks in purchasing as too insignificant to be bothered with. Such an attitude, of course, is fatal. Poor purchasing methods, like poor employment methods, inevitably show up on the cost sheet and are *reflected in* reduced profits. There are just

as many failures due to poor buying as to poor selling.

Hats off, then, to the purchasing agent, who helps the other departments of the factory succeed by giving them the right start! His function is to buy the raw material and supplies which go into production, and the profits of his department are the thousands of dollars he saves every year by careful buying. He is an expert in determining sources of supply, quality, standards, and all other factors which enter into profitable buying.

His abilities must extend far beyond the point of knowing what to buy. He must know when to buy and where. He must be in close touch with market conditions.

The Purchasing Department

Having bought, his department is charged with seeing that the goods received are right in quality and quantity, and that they are delivered to the proper store keeper or other responsible person. The purchasing department also checks all bills to safeguard against their being paid twice.

Unit IV, in its discussion of the procuring and handling of materials, has already given some attention to the subject of purchasing. The purpose here will be to show the records which are used in the most successful purchasing departments—for it is clear that to

do business properly the purchasing department must have a well-balanced system based upon accurate records. In order to see what records are kept, let us see how a purchasing department operates.

We will assume that a certain job calls for the use of varnish of a certain grade for finishing. A PURCHASE REQUISITION is drawn specifying what is required, the grade and quantity, and when delivery must be made. It also tells to whom the purchase is to be delivered—whether to the foreman or workman in a certain department

The Purchase Requisition

PURCHASE REQUISITION No. *18975*

Date *Dec. 2, 1918*

To Purchasing Department: Please order the following:

When received deliver to *Automatic* **Notify** *Mr. Turner*

(If for Stock state "Stock.")

For Part or Order No.	Quan.	Description	Date Wanted	For Use of Purchasing Department Only: Date Ordered	For Use of Purchasing Department Only: Purchase Order No.
11571	*500 lbs.*	*$\frac{5}{16}$ Brass Rod (Round)*	*12/15/18*		

Signed *Chas. Turner.* **Department** *AUTOMATIC*

Approved by *J. T. Waters*

All goods delivered to "stock" when purchased, must be drawn out upon Material or Supply Requisition.

for use on a particular job or whether to the store room for future use. Where a purchase requisition specifies delivery to a department for a particular job, it usually must go first to the store room. This is to save needless buying in case the material is already in stock. If it is not in stock, the stores clerk will initial the requisition and pass it on to the purchasing department.

This puts the responsibility of supplying the varnish squarely up to the purchasing department. *Where* to buy now becomes the important question. It is easy enough to get a list of varnish houses from a trade directory, but actual experience with the firms is important if one is to make the right selection. In the case of materials which have been bought in the past, the purchasing agent will have full records of his past purchases, will know what prices he paid, what service he got both in quality of goods and in delivery. It may be that he will have a file of current quotations of basic materials, this file being made up of the quotations sent out by the sellers daily, weekly, monthly, or at irregular intervals, as the case may be.

A record form for keeping account of places to buy is the SOURCE OF SUPPLY CARD. Where this form is used, it is necessary only to take from the indexed file the card bear-

ing the name of material to be purchased. On the face of the card will be found a complete record of previous transactions in this material—dates of purchase, where each purchase was made, and the prices paid. As new purchases are made they are added to the card, thus keeping its record up to date. In addition to such a file, the purchasing department usually has a complete file of catalogs.

Records of Where to Buy

Name of Article *Stools (metal) with back rest*

Date	Order No.	Bought from	Quantity	Unit Cost	Cost	REMARKS
3/5/14	2741	Gillespie Metal Wks.	300	1.10	330	Higher
4/29/17	12427	Art Metal Constn. Co.	450	1.50	675	prices due
7/30/17	12901	Art Metal Constn. Co.	50	1.60	80	to war
10/15/18	19242	Gillespie Metal Wks.	500	2.20	1100	conditions

Source of Supply Card

Unless the need for the varnish is so immediate that it must be ordered at once the purchasing agent will select the most likely sources of supply and ask for estimates on the amount required. The REQUEST FOR ESTIMATE is used in asking for this information.

If the varnish must be of a certain specified quality, the firm quoting the lowest price will usually receive the order. This rule is not always governing, since quick delivery may

REQUEST FOR ESTIMATE PURCHASING DEPARTMENT Estimate No. *1089*

THE GEORGEN-GOODWRIGHT COMPANY

New York, N. Y.

Estimate to be returned by *Nov. 30/18* (Date)

To *U. T. Hungerford B. & C. Co.,*
New York, N. Y.

Please quote prices hereon for furnishing the articles enumerated below, and delivered to *Rochester Plant*

Quantity	Description	Price	Terms	Delivery
500 lbs.	*$\frac{5}{16}$ Brass Rod (Round)*			

Please return promptly

THE GEORGEN-GOODWRIGHT COMPANY

J. Delanoy Purchasing Agent

be important, and it may be necessary to buy from a firm whose price is higher than the lowest because it can ship the varnish within the time required. It is often the case that quality of material is not strictly specified, and then the purchasing agent is able to trade around, consider different grades, and select the grade which he believes will best serve the purpose. In all such trading, of course, it is not alone price, but quality as well, which must be taken into consideration. The purchasing agent seeks to get the material which will meet his need at the lowest price obtainable.

In considering grades, comparing samples, and making a selection, he must be on his guard constantly. Various standards of comparison are possible, surface appearances are frequently deceiving, and there is always the possibility—especially in dealing with new or unknown firms—that the selling organization may be trying to "put one over" by dishonest means.

The Story of a Sponge Deal

The purchasing department of a large firm operating several baking plants received a requisition some time ago for sponges. The sponges were required by the firm's garage for use in washing delivery cars. The order called for a new material so far as the purchasing department was concerned, as other means of washing the

cars had been used in the past. So a representative number of sponge houses were selected, requests for estimates were sent them, and in due time replies were received. The replies settled one question immediately; that the sponge to be used for automobile washing was a sheep wool; upon this they all agreed. It was also indicated that sponges were sold by the pound. Then the prices were compared, with the following startling results: $4, $5.25, $6.25, $7 and $8.75 per pound. And all quoting on "best grade sheep wool sponges"!

Instead of grabbing that bargain at $4, the purchasing agent asked the firm to submit a sample. A similar request was sent to the firm which quoted $8.75. In due season the $4 sample arrived, accompanied by the salesman. It looked all right, and if weight meant anything it was certainly durable. The salesman was asked to leave his sample pending decision, and shortly after his departure the $8.75 sample arrived with a representative of its firm. It looked much the same as the other sponge, though less durable. As to weight—this sample weighed but two ounces, the other five.

"I'll tell you," volunteered the salesman, "I'm here to sell my goods, not to knock the other fellow's. I'll leave this sample with

you. Soak both sponges in water, wring them out, and change the water twice in the course of the day. Then dry them. If you decide to give me the order, just 'phone me. A twenty-pound bale will give you about eighty sponges. Should you decide to buy the cheaper sponge, I'll make you a present of my sample. You'll need it."

This is how one purchasing agent learned the difference between a "loaded" sponge and a pure one. And the incident comes back to him clearly every time he has pancakes for breakfast. For as the golden syrup flows upon the steaming cakes, he wonders how much corn syrup is wasted daily loading sponges to be sold at $4 a pound.

It may be necessary for the purchasing agent to ask for samples of varnish, and submit them to various tests before making his final selection. The question whether or not to require samples and buy by test is one which varies with the kind of material and with other circumstances. If the purchase is small, elaborate tests may be more expensive than serviceable. On the other hand, if the quantity is large and wide variations from the standard are possible, right purchasing demands testing. It is a common practise among modern industries today to buy coal by test.

When the place to buy has been decided upon, the purchase is made by means of a PURCHASE ORDER. In one system, this form is made with two carbon copies. (1) The original, typed on a yellow sheet, is sent to the firm from which the goods are being purchased. (2) The duplicate, typed on a blue sheet, is kept by the purchasing department as its office record. (3) The triplicate, typed on a brown sheet, is sent to the stores clerk as his authorization to accept the goods upon their arrival. The different colors are used to save time in handling. Of course any three colors might be used; those specified here are the combination with which the writer is familiar. Also in some systems of purchase orders more than two carbons are used.

The Purchase Order Made in Triplicate

Upon arrival of the shipment of varnish, the stores clerk checks it against the brown copy, and sends this brown copy back to the purchasing department with notation that the goods have been received as ordered. The purchasing department adds this information to the record on its blue copy, and returns the brown copy for the clerk's file. When the goods are delivered to the person who requisitioned them, the stores clerk gets him to sign a receipt for them upon the brown copy. If the goods were purchased for stock,

PURCHASE ORDER ORIGINAL **The Georgen-Goodwright Co.** New York City

Purchase Req. No. H *18975*	**Purchase Order No.** H *22307*
Ordered By *Turner*	**Date** *Nov. 28/18*
For *Auto Department*	**Charge a/c** *Raw Mat'l*
Unit Package	**Alarm Balance** *50 lbs.*
Trade Discounts	**Payment Terms** *2/10*

FIRM *U. T. Hungerford B. & C. Co.*
ADDRESS *New York, N. Y.*

SHIP TO *Our Rochester Plant* **F. O. B.** *New York*
VIA *N. Y. C. Freight* **CLASSIFICATION**

Accepts your Quotation of	Confirms our Order of	Date Wanted
Nov. 25, 1918		*at once*

For Part or Order No.	Quantity	DESCRIPTION and SPECIFICATIONS (See Conditions on Reverse Side)	Unit Price	Unit	Total	
11571	*500 lbs.*	$\frac{5}{16}$ *Brass Rod (Round)*				

Our Order No. must appear on all invoices. B/L or other Shipping Receipt in DUPLICATE must accompany all invoices for goods shipped other than to this office.

SIGNED ON REVERSE SIDE SUBJECT TO CONDITIONS THEREON

This original PURCHASE ORDER is sent to the firm from whom purchase is to be made. One carbon copy is made for the stock-room, and one to be kept as office record of the purchasing department

the brown copy is used in entering the new material upon the stock inventory.

All invoices and bills, as they are received with or following the receipt of purchases, are sent first to the purchasing department for its O. K. as to the receipt of goods and the correctness of the prices and terms. After checking an invoice, a memorandum of this fact is noted by the purchasing department on its blue copy of the purchase order. This safeguards against the possibility of paying a bill twice should a duplicate invoice be received for the same goods.

Before sending the invoice to the accounting department, however, it is necessary that the purchasing department indicate the cash discount to be deducted, if any. Frequently a concern has a regular cash discount whose terms are printed upon the invoice or bill. It may state that 2 per cent may be deducted if the bill is paid within 10 days, or net if paid within 30 days. However, it is quite frequent for a firm to grant special terms to a large or regular customer, and in that case the purchasing department would know what these terms are. It is a convenience to keep a separate card index of all supply houses, showing their terms, and from this quick notation of the terms can be made upon each invoice. Then the invoice goes to the ac-

counting or bookkeeping department which pays the bill when it is due.

Unit IV has already discussed the method of keeping account of material as it is added to and withdrawn from stock. Sometimes the PERPETUAL INVENTORY is called a "going" inventory, as it is also called the balance of stores sheet. The perpetual inventory is one of the most important of factory records, and while it is not directly a record of the purchasing department it is vitally important as a regulator of purchases. For, as has been explained in Unit IV, it automatically shows by its system of maximum and minimum control when stock is getting low, and so warns the stores department when to draw a purchase requisition for new stock.

The Perpetual Inventory

The perpetual inventory is to the stores clerk what the cash book is to the cashier, and requires the same care in handling. The thousands of dollars worth of stores on hand is no less valuable than the money it represents. It is, in fact, the equivalent of money. When funds are received the cashier enters the amounts on the "received" side of the cash book. When payments are made they are entered on the "paid" side. The difference between the two represents the cash balance, *or cash on hand.*

RAW MATERIALS AND SUPPLIES

ARTICLE *Brass Tubing* SIZE *No. 4 Special* MAXIMUM *500 lbs.*

USED FOR PART *Oil Feed* WEIGHT *4½* PER 1000 PARTS MINIMUM *100 lbs.*

ORDERED			REFERENCE		QUANTITY			UNIT COST	VALUE						COST
Date	Req.No.	Quan.	Date	No.	Rec'd	Deliv'd	On Hand		Rec'd		Deliv'd		On Hand		Per 100 lbs.
1918			*1918 Inv. 4/1*	*295*	*450*		*450*	*78c*	*351*	*00*			*351*	*00*	*78 00*
			Req. 5/20			*350*	*100*				*273*	*00*	*78*	*00*	*78 00*
5/25	*18421*	*200*	*Inv. 7/20*	*498*	*210*		*310*	*85c*	*178*	*50*			*256*	*50*	*82 74*

Perpetual Inventory Record

The perpetual inventory is operated in exactly the same way. As materials or supplies are placed in stock, the quantity received and the cost are entered in the received column of the inventory card. As anything is given out of the stock, it is entered in the delivered column. The balance changes with each receipt or delivery, and represents the stock on hand at any time. There is this difference, however, between the cash book and the perpetual inventory: The cash book represents one thing only, cash, and for this reason all entries are made in the same place. The perpetual inventory represents many different kinds of materials and supplies, and it is, therefore, necessary to have a separate card for each kind.

In a plant where the perpetual inventory is used, there should rarely be emergency purchasing—since the inventory gives warning of the need of additional material long before any acute shortage is felt. Of course in all industries there are occasional emergencies; the need for a new kind of material not carried in stock may develop over night, and then it is up to the purchasing department to get the goods within the time required at the most economical outlay. By systematizing the purchasing, so that the experience *with past purchases* is preserved in convenient

records and so that the placing of orders and checking up the deliveries is kept under easy and full control, such emergencies may be met with the least extra expense and the ordinary every-day procuring of supplies most successfully managed.

IV

Safeguarding the Material

IT is not enough to systematize the purchasing of materials. After they have been procured, the materials must be safeguarded—both in the store room and in the operating departments.

The store room may be thought of in terms of a bank. Just as the bank is a place for keeping money, so the store room is a depository for materials. Just as the bank is held responsible for the money intrusted to it, and must give an accurate accounting of all it receives and all it pays out, so the store room is responsible for all material delivered to it.

The Store Room as a Bank

In order to get money from a bank you must present a check to the paying teller. If the check is properly drawn by a person who has authority to draw checks on that bank, he will pay you the sum of money called for by the check. The teller keeps the check, for that is his receipt for the money paid you. At the end of the day he counts his cash and subtracts the amount then on hand from the total of cash intrusted to him. The difference

will be the amount of money he has paid out, and the sum total of his checks must equal this amount. In other words, for every dollar less than he had at the beginning of the day he must show the equivalent in the form of a check. Otherwise, the teller's accounts are out of balance and he will be held responsible for the shortage of cash.

Stores-room procedure is much the same. In order to get a supply of material, you must present to the stores clerk a MATERIAL REQUISITION. This requisition corresponds to the bank check. It authorizes the clerk to deliver to you a certain amount of a certain material. On delivering the material, the clerk keeps the requisition, just as the bank teller keeps the check, and the sum total of requisitions for the day must equal the sum total of material drawn out that day.

It is easy to see how such a system safeguards material in the stores-room. It is impossible for some dishonest employee in that department to pilfer or steal articles from stores, without the stealing being detected. It is impossible for a too generous stores clerk to hand out material indiscriminately to other employees. For everything missing from stores the clerk must show a requisition, and since the requisition must be drawn and O. K.'d by some foreman or other authority

MATERIAL REQUISITION

No. 275

Sept. 20 1918

Oil Shed (NAME OF STOREROOM) STOREROOM: Please deliver to T. Sweeney (EMPLOYEE'S NUMBER AND NAME)

The following material and charge same to Automatic Dept. (DEPARTMENT STAMP)

Part No.	ARTICLE	FOR PART NO. OR SHOP ORDER NO.	QUANTITY OR WEIGHT DELIVERED	DO NOT WRITE BEYOND THIS LINE	PRICE PER UNIT	AMOUNT
	5 Gal. Mche. Oil					

Chas. Turner
DEPARTMENT FOREMAN

Automatic Dept.

DATE OF RECEIPT

RECEIVED BY

BILL NO.

DATE

THIS SPACE FOR BILLING DEPT.

outside his department, it is practically impossible for him to come into possession of a requisition except in the ordinary course of operations.

What about the material after it leaves the stores-room? The requisition system is a check on the stores department and safeguards material there. But how about material in the hands of the workman? How may the management make sure that it is not wasted or misappropriated?

Safeguarding Material through the Plant

In the first place, the function of issuing requisitions is strictly controlled by the foreman. Usually, when a workman needs material for a job upon which he is working or which he is about to begin, he makes his request to the foreman (if the delivery of the material has not already been provided for), the foreman or his clerk draws the requisition; and the requisition must bear the O. K. of the foreman before it will be honored by the stores-room.

In a small plant it is possible for the foreman to keep in close touch with the details of the various jobs, and know how much material each job requires. Any requests for questionable amounts of material would arouse his suspicions at once, and result in a speedy investigation. But in a large plant, it

is not possible for the foreman to keep track, personally, of the needs of the various jobs. He may have one hundred or more men under him, and many machines, and his duties are varied and numerous. The signing or initialing of a requisition then becomes a perfunctory matter, and unless some additional safeguard is provided, it becomes easily possible for the wasteful or the dishonest workman to obtain more material than his work requires.

How One Manufacturer Discovered a Leakage

A Western manufacturer discovered this in a rather convincing way one day when he passed a junk shop as a wagon-load of "junk" was being unloaded. He noticed that most of the load consisted of brass pieces. They looked familiar, and, stopping to investigate, he found that they were castings from his own shop. Of course he demanded the name of the seller, traced the "junk" back to one of his factory employees, and after an inquiry which disclosed that the man had been engaged in systematic stealing from his employer for a series of years, discharged him. Then a full investigation was made of the system which allowed such a thing to take place.

The industry was a piano factory. It had a requisition system in full force throughout all departments of the plant, but it was soon

discovered that in its accounting of material used in making parts the system was weak. For example, when a primary operation was to be performed, for which raw material from the store room was required, a job ticket was issued describing the part to be made and the operation to be performed. On the strength of this job ticket the workman would then get a requisition from the foreman's clerk. Perhaps it was a requisition for tubing, for screws, or for brass castings of the kind which the owner found at the junk shop. Whatever the material, the workman specified the quantity needed, the clerk made out the requisition, the foreman initialed it as a matter of course, and on presenting the requisition to the stores clerk the workman got the material. After he had finished his job, the workman would turn his product over to the stock clerk in the customary way.

Output Should be Checked against Material

The weak spot in the system lay right here. There was no check of output against material. The dishonest workman had simply got more castings than he needed, and kept some of them out, carrying one or two a day home in his overcoat pocket. Nobody suspected the stealing, because for every lot of material he withdrew, he turned in a lot of finished stock.

Under the new system which has been installed in that plant, every job ticket for a part to be made from raw metal or castings calls for a specific weight of metal. The requisition is issued for this weight only; and as an additional precaution the job ticket must accompany the requisition to the stores-room. When he fills the requisition, the stores clerk initials the job ticket—thus indicating that the quantity of material called for in the requisition and given out by him corresponds with the quantity specified in the job ticket. When the job is completed and the finished parts go to the stock clerk, he notes the amount of material furnished to the workman and then checks up the finished parts against this record. He is able to do this by means of a list in which is indicated exactly how many parts of each kind should be obtained from a certain quantity of material. Thus, the workman's production must check up with the record of material delivered to him, and any shortage must be explained immediately.

Many plants have found this system successful. A New York motor truck factory found it necessary to adopt a somewhat different system, due to peculiar circumstances in its manufacturing. Its production was entirely manufacturing to order. An order

might consist of one truck of a special design, or it might call for twenty. In either case, requisitions for material were varied and numerous. Material issued from the stores-room could not be charged to part numbers, as was the case in the piano factory; for the manufacturing was not standardized on the basis of the production of parts. Each order was separate in itself, and all costs were chargeable to the order.

Budgeting the Material

So in this plant a system of budgeting the material was devised. From the full set of blue prints for the particular order to be manufactured, a complete schedule of all material required is drawn up. This schedule, or BILL OF MATERIAL, shows the contract or order number, the goods to be made, and the date promised for delivery. It contains a detailed list of materials required, showing for each material the number of the drawing calling for its use, the kind of material, the size and quantity required. The stores clerk is authorized to recognize requisitions for each order only to the extent of the material shown upon his copy of the bill of material, or in exchange for material that has already been so issued but spoiled during the course of the work. As each requisition is presented, the goods delivered are checked from the bill of mate-

rial, and the number of the workman entered beside the item. Any demands beyond the quantity authorized upon the bill of material are investigated, and since the record shows exactly who received the goods, the responsibility or irregularity may be definitely placed.

One successful production man has said of this budgeting system: "Where it is adaptable, it stands without parallel for safeguarding material."

There is, however, considerable work about a large plant in which it is not possible to have an exact check on material. An example is an order for the repair of machinery or equipment. On such an order, the total material cost is first estimated and this estimate later compared with the actual material delivered upon the order. Or, where there are similar repairs from time to time, comparisons are made. Either way affords at least some means of checking waste or pilferage.

Of course it is the cost department, rather than the stores department, which keeps the real check on material consumption. In computing material cost for a job the cost department will notice any excessive requirements and report them.

Shop supplies, such as oil and cotton waste, should when possible be requisitioned in

quantities, and rationed out by the foreman according to the needs of the workmen. This is perhaps as good a way as can be devised, and eliminates the writing of numerous requisitions besides saving much time which would otherwise be consumed in sending to the store room for every individual requirement.

Work in Process

In the factory, raw materials cease to be known as such the moment they enter into the process of manufacture. They then become "work-in-process." The value of work-in-process includes the cost of all raw material used plus the cost of all labor spent upon the material up to its present state of completion, together with a proper proportion of overhead expenses. It is important to know the value of partly finished goods at any time, and in modern plants an accurate record is kept in detail. This record is in a form similar to that of the perpetual inventory described for raw material. It is in fact a continuation of the perpetual inventory, having its beginning where the other ends.

This record is known as the WORK-IN-PROCESS LEDGER, and is kept in either loose-leaf books or on cards. In one plant engaged in manufacturing standard parts, later to be assembled into the finished article, the card

PART NO. 2742 **WORK IN PROCESS** OPR. NO. 2

PART NAME Buck Plate USED ON Model 1412 OPR. NAME Stamp

FROM PART NO. (Raw Mat'l) TO PART NO. 2842 DEPT. NO. 12

REFERENCE			QUANTITY				VALUE								COST Per M.	
				DELIVERED			THIS OPERATION COST			DELIVERED						
Date 1918		Source	Produced	Sold	Scrap	On Hand	Material	Labor	Overhead	Sold	Scrap	On Hand				
Jan.	1	P/R	2500			2500		4 50	2 25			6	75		2	70
Feb.	27	"	10000			12500		15 00	7 50			29	25		2	34
Apl.	20	"	5500			18000		8 00	4 80			42	05		2	34
May	12	S. Tkt.		15000		3000				35 10		6	95		2	34
May	15	S. Rep.			25	2975					75	7	70		2	69

WORK-IN-PROCESS RECORD

(An operative causing "scrap" must bear the entire cost of the spoiled work)

system is used, a card being set apart for each operation. Thus a part requiring six operations would be represented by six cards —one for each operation. All costs for material, labor and overhead involved in the operation are entered upon its card. Each card shows at any time the quantity of parts on hand which have passed through the operation, as well as the cost value of these parts. As the same operation is performed again and again, valuable comparisons may be made.

In another factory the parts may be worked through the various operations in standard lots, say, of ten thousand each. In this case all costs for material, labor and overhead for the lot, would first be gathered upon a card; and then the total cost for the lot transferred to the work-in-process card for the part. Deductions are made and balances reduced as parts are delivered for assembly, finally to become finished stock.

The details of such a system vary with differences in plant and operation. Where a plant manufactures to order, or works upon special contracts, a card would be used for each order. Other classifications would be according to jobs, articles, or processes. The system must be shaped to conform to specific manufacturing conditions as well as what is

being manufactured. The purpose of the work-in-process ledger, is, however, the same in every case—to know exactly what is in process of manufacture at any time and the cost thereof.

Inspecting the Work

As work in a factory progresses from operation to operation, from minor to more complete assemblies, finally to issue as finished product, the matter of inspection plays a very important part. The degree to which work is put to the test depends upon the mechanical correctness required. Unit IV has already discussed the use of gauges. In the manufacture of practically every article some parts or operations are more critical than others; hence, while some parts require a 100 per cent inspection—by which is meant, every part must be inspected—others might need only a 20 per cent inspection, or the testing of one part in every five. If in a 20 per cent inspection numerous defects are shown, it might be necessary to go through the entire lot.

The work of inspecting may be carried on at the work-bench or the machine of the mechanic, or it may take place in a regular inspection room equipped for that purpose. The former is usually referred to as floor inspection. Floor inspection, when it can be employed, has an advantage in that faults may

be corrected while the operation is in progress, and further work thus saved from being spoiled.

As work is passed upon by the inspectors, the defective parts are removed, and records are made of the spoiled work. These records are known as SPOILED WORK TICKETS, or scrap tickets. From these tickets a scrap report is drawn up from time to time which shows the management exactly how much work has been spoiled in each department, and the cost of it. *Method of Handling Scrap*

The spoiled parts are kept separate from the good work. Afterwards they are gone over by the chief inspector, or some other competent person with a view to finding out which parts may be repaired. If the spoiled work is in the form of assemblies, it may be put through a "knock apart" operation, and the good parts used over again.

In a large plant, all operations upon a part, article, or order, are seldom performed in the same department. It therefore becomes necessary to keep the work moving from department to department. This may be done in one of two ways: (1) by direct shipment from one operating department to another, or (2) by sending all parts as rapidly as they are finished in the various operating departments to a central partly-finished stock room,

from where each part may be routed to its next operation.

In either case, when a department has finished its operations the goods are accompanied to their next destination by a SHIPPING TICKET. The ticket illustrated on the opposite page is made in triplicate, the original going with the goods, while a copy is retained by the department sending the goods. The cost department receives the duplicate copy of the shipping ticket, and deducts the cost of the work from the work-in-process account of the department delivering the goods and charges it to the work-in-process account of the department receiving them. The duplicate copy is signed by the receiving department, and returned, acting as a receipt.

The Shipping Ticket

The purpose of all these records is clear. They are to safeguard a valuable asset, *material,* against waste. More than that, without such records it would be impossible to know the actual cost of production for it is on the basis of the requisitions, the job tickets, the spoiled work tickets, and other material records that the cost department gets much of its information which shows up finally in the cost summary. Thus these records not only insure against leakage of *materials* through carelessness or dishonesty,

but they also provide valuable data for guiding future operations.

Sometimes a workman will protest against the "needless red-tape" of requisitions. He has a mistaken idea of production efficiency, and the foreman who is alive to his job will

INTER-DEPARTMENTAL SHIPPING TICKET

No. *4728* Date *November 1, 1918*

To *DRILL PRESS* Dept.

Part No. *21242* Part Name *Top Plate*

Last Operation No. *2*

Last Operation Name *Mill*

Next Operation No. *3*

Next Operation Name *Drill*

Quantity *2550* Delivered by *P. Brown*
Storekeeper

Milling Dept.
Department

THIS COPY TO GO WITH MATERIAL

not miss such an opportunity to drive home the lesson that *records which insure against waste and cut down costs are productive factors.* They help along the success of the plant by keeping one element in production, material, moving in the right direction—the direction of lower costs.

V

Two Letters on Equipment, from a Manufacturer to His Son

DEAR RALPH:

It makes me mad clean through to hear you say you find little at the International plant that would be useful to us here. If you are going to make worthwhile the money it is costing us to pay your expenses investigating different plants and systems so as to better our own, you will have to get down to brass tacks right away, and learn to see the bigness of the little things.

Within the past thirty days I have had a dozen different men in our plant tell me that for some reason they lose a lot of time whenever they start a new job because it takes so long to get the tools and fixtures. I have questioned some of those who came to us from the International, and from what they tell me getting tools over there is a little matter that takes about as long as getting an overcoat checked at the hotel coat-room—and is worked about the same way.

We've spent a lot of money—and made a whole lot more—getting the best system into our business, and are willing to make further investments in the same way. Please notice that I say *invest* and not spend. I don't expect that everything you see can be picked up bodily and put right into use here; but reading between the lines of your last letter, I am inclined to tell you that unless you apply your imagination to the things you see, you will never make much headway.

Mr. Thompson dropped in on me this morning, and told me he heard you were over at the International telling them all about the fine ways we have of doing business here. Perhaps that explains why you are finding so little of the stuff you were sent for. They are pretty modest people at the International, and the chances are you have so filled them with your own perfections that they are a little afraid or ashamed to reveal theirs. Your rule No. 1 on this trip is to use your ears and not your tongue. By applying the padlock in the proper place you will find you can get a whole lot farther in much less time, and besides you will need only half the equipment.

Speaking of equipment reminds me of the fire we had at the plant five years ago. We had been pretty careful about insurance mat-

ters, and were cautious always to carry enough. We were able to talk turkey to the insurance company, and show them through the detailed perpetual inventories just how much raw materials and supplies we had on hand; and the same was true of our work-in-process. We had little trouble, therefore, in making a satisfactory deal on these. However, when we came to talking about the equipment and machinery, I felt pretty foolish I can tell you. We simply had to surrender hands down, and take the terms offered. Here we were, one of the biggest plants in this section, and one of the best equipped, too, but all we had to show for it was an account in the ledger called "machinery and equipment," which said we had some of that to the tune of about $450,000. When we wanted to find out how this amount was made up, or in other words, just what part of this each machine represented, we simply had to wave the white flag. It couldn't be done.

When Lack of Equipment Records was Costly

The insurance company had their appraisers about the plant for a few days, and when they suggested an appraisal of the machinery which the fire hadn't damaged, they to pay the difference between this and the *total figure*, it looked to me like a good

scheme. I changed my mind, however, when the appraisal figures footed up to a little over $400,000; and since I lost fully a quarter of the plant, I felt pretty sore, and was sure I was getting a raw deal. I wanted to fight. But they were the most amiable people you ever saw, and when they suggested a second appraisal by two experts, they to select one and I the other, I naturally had to agree.

We might have saved the fees, however, for the result was about the same. I took the $50,000 they offered and figured my lack of equipment records cost me another fifty. It also showed me where being too conservative cost money; for we had been writing off a fixed percentage each year to cover the depreciation on all the machinery, while as a matter of fact there are hardly two machines in the plant with the same life. Besides this, as I afterwards learned, a good part of the equipment we made ourselves never found its way into the equipment account. These things explained of course why the machinery and equipment valued on our books as $450,000 was in reality worth a good deal more, and why I collected only $50,000 when I should have received at least $100,000.

However, I have used that experience many times since the fire, and that fifty thou-

KIND OF EQUIPMENT *B. & S. 4 Spin. Drill Press* LOCATION *D. P. Dept. Post 4* No. *2187*

BOUGHT FROM *Gibson Tool & Machine Co.* ADDRESS *New York, N. Y.*

DATE BOUGHT *Jan. 5, 1915* DATE RECEIVED *Feb. 20, 1915* COST: *$890*

ESTIMATED LIFE *20* YRS. ESTIMATED REPAIRS *$250.* FRT. & CTGE: *23.96*

ESTIMATED JUNK VALUE *$75* SETTING UP: *23.50*

DEPRECIATION PER YR. *$55.87 (942.46−75+250÷20=55.87 per yr.)* TOTAL COST *$942.46*

DATE		MEMO.	ADD REPAIRS		DEDUCT DEPRECIATION		PRESENT VALUE	
mo.	yr.							
Jan.	*1915*	*Total cost value*					*942*	*46*
"	*1916*	*For year 1915*			*55*	*87*	*886*	*59*
"	*1917*	*For year 1916*	*7*	*50*	*55*	*87*	*838*	*22*
"	*1918*	*For year 1917*	*30*	*00*	*55*	*87*	*812*	*35*

RECORD OF PLANT EQUIPMENT

In the system described in Chapter V, there is one of these investment ledger cards for each piece of equipment in the plant

sand dollars has come with interest since then. Today, as you know, we have a complete record of every piece of machinery in the plant. Each machine is numbered, and is recorded in detail on a card bearing that number. Instead of using a fixed rate for depreciation on all machines alike, each machine is considered separately. While formerly little attention was given the equipment we made, it makes no difference now whether we make it or buy it outside. For that made here, accurate costs are kept of the material, labor, and overhead. Now when our books say we have $800,000 worth of machinery, I need only refer to the INVESTMENT LEDGER, to find out what part of that $800,000 each piece represents. Since each card gives the location of the machine, we can now in case of fire, give a true account of each machine, and be in a position to collect one hundred cents on the dollar—instead of fifty.

The Investment Ledger

I simply mention this in passing to point out that in an up-to-date manufacturing plant nothing is little—everything is big. And if "many a little makes a mickle" is a good enough slogan for Uncle Sam to use to sell a couple of billion dollars worth of War Saving Stamps, it certainly ought to be good enough for us to carry into our plant to help

beat the other fellow when it comes to making typewriters.

Your father,
JOHN RUSSELL.

DEAR RALPH:

There is a heap of real affection between a good workman and his tools. This is the one big reason why tools should be handled tenderly, why they should be kept fit, and why they should at all times be carefully and systematically filed that no time may be lost when they are needed. The manager of a plant or the foreman of a department is in a poor position to criticize the inefficiency of his workmen when they are able to point at weaknesses in the routine or system over which they have no control. This is why I am particularly glad you lost no time in looking into the tool-room situation at the International, and why I went a hundred and fifty miles out of my way last month in order to see how Hopkins of the Campbell Company keeps track of his tools and fixtures.

Between the ideas that came to you as a result of your study of the situation and the suggestions brought forth by my own investigation we are now doing business as we should, so far as our tools and fixtures are concerned. The workmen no longer have to

wait. When they want a tool it is ready for them, and as they start on a new job the fixtures necessary are immediately located. In each case the records show who has each tool or set of fixtures. When, in my letter to you some time ago, I compared the tool-room scheme to the coat-room systems used at most hotels, I pretty nearly described what we now have in operation—barring the tipping feature, of course.

A Tool System that Works

Small departmental tool rooms or tool cages, have now been established. Wire partitions form the inclosure. Metal shelving has been erected for the accommodation of galvanized iron boxes, both small and large, into which are placed the various tools and fixtures. These boxes are numbered—some to indicate machines, others to represent parts. Then there are others for the numerous small bench and machine tools which are constantly in demand, such as drills, reamers, files, etc., of which there is a great variety due to the many sizes in use. The latter are kept in boxes serially numbered. A small book index tells exactly where each particular size of every tool is to be found. The tool cages are also used for storing the shop supplies to meet current needs, such as machine oil, lard oil, cotton waste, benzine. These supplies are

economically rationed out upon instructions from the foreman.

So much for the tool cage itself, except to say no one but the tool clerk is permitted to enter it. He is solely responsible and is held accountable for all the tools, whether in the tool cage or in the hands of the workman. It is also part of his job to see, as tools are returned, that they are in good condition. Those that need sharpening or repairing are put in proper condition immediately, so that there will be no delay when they are again required.

Brass Checks as Tool Records

Each workman has been supplied with a set of ten brass tool checks, bearing his number. These he uses to exchange for tools as they are required. As he returns the tools, his checks are given back to him. If a man quits or is discharged, he is obliged to turn in his full set of checks before getting his final pay. The method of keeping track of the tools in the hands of the workmen is very simple. As a brass check is received, it is placed in the box from which the tool is taken. A colored tag bearing the date is also hung upon the outside of the box. A glance about the tool cage is all that is necessary to tell exactly which boxes have tools missing from them. The dates on the tags show the tool-cage clerk which men

—if any—are holding out tools beyond a reasonable time.

You will probably not recognize more than a passing acquaintance in the scheme as we have it in operation here. It is nevertheless a direct result of what these other methods, reported by you, have suggested. And therein lies the usefulness of the study of any subject. Little benefit is derived from the mere acquisition of knowledge. Business today is established upon ideas and is operated according to the ideals of those in control. It is organized *personality*. Hence, no matter how much the product of one enterprise may resemble that of another, we seldom if ever find exact similarity in systems or records. It is the correct application of knowledge that makes a system practical. However important experience may be, it has little force so long as it consists of disjointed facts. The underlying principles must be correct. Then it becomes a simple matter to transfer the good we find in the methods used by others, to meet the conditions required by our own enterprise.

It's a good thing sometimes to get a glimpse of ourselves from the outside. We are often so close to our own proposition that much is overlooked, and just as we are likely to criticise others for conditions not half so bad as

those we ourselves live through every day, so they in turn are able at times to give us some pretty good pointers regarding our own affairs.

An Outsider's Discovery

Some time ago a young man applied here for a job. He said he understood shop routine, and thought if he could be turned loose in the plant for a few days he would be able to make a job worth his while and ours. He seemed a likely sort of chap, and sounded some interesting ideas. The proposal he suggested was an experiment from which some good might come, so I took him on. After he had wandered about the plant for a few days, he presented himself at the office one morning with a small memo. book.

He had been investigating idle machinery. The first morning out he started through the plant, and made a record of every machine found idle. When he had completed the circuit, he started all over again checking off those then running, and adding those since made idle. While the data he submitted was only a rough estimate, it nevertheless revealed that we were losing considerable money because machines were not kept running all the time.

We went further into this matter of idle *machinery*, and finally planned an IDLE MA-

Idle Machine Tag

Machine No. *221*

Date shut down *Nov. 25, 1918*

Time ____ **A.M.** *2:30* **P.M.**

Reason: *Broken lever*

Date operation resumed *Nov. 26, 1918*

Time *11* **A.M.** ____ **P.M.**

Elapsed time *5½* **hours**

Machine cost per hour $ *1.10*

Cost of shut down $ *6.05*

IMPORTANT **This tag must be attached to machine as soon as shut down and removed as soon as operation is resumed.**

This form of tag keeps down machine idleness

CHINE TAG. Now the moment a machine becomes idle, no matter what the reason may be, one of these red tags is affixed, the date and hour is written on the tag, and the reason for idleness is noted. When the machine is again put into operation, the tag is removed and the date and time noted. From these tags the idle time is figured and the causes analyzed. Every Saturday a report is made for each department, and the foreman called upon to explain. The scheme has worked wonders. The first week the startling discovery was made that 14 per cent of the machinery in the plant was idle for one cause or another—one because of a minor repair needed, another because no work was ready, a third because of an absent operator. Think of it! One-seventh of the plant absolutely wasted. One floor out of every seven—for which thousands of dollars are paid annually for rent, light, heat, power, insurance, etc.—allowed to stand idle.

Making the Foremen See It

We lost no time in educating our foremen, as well as every workman in the plant, as to the meaning of idle machinery. We photographed several machines, and showed in a schedule below just how much it cost to maintain them. We showed the exact time each day the machines were not in use, and the total idle time

for the week. We gave the reasons for the shutdown, and explained how the idle time could have been reduced.

As a result, the men have been impressed with the expense of an idle machine. It never occurred to some of our best foremen that idle machinery is even more costly than idle workmen. Quick improvement followed, and the percentage of idleness steadily decreased. After a couple of months it found its level around 2 per cent, which we think reasonable for a plant of this kind. That little educational work did the trick. We find it generally true if you take the men into your confidence, explaining things carefully—not simply telling them, but showing them—they will play the game fair. We did this by means of the photographs. They saw and they responded.

We continue the red tag, however. It is decidedly unpopular, but mighty efficient. As soon as one is attached to a machine, the foreman on the job takes quick action to get the red tag removed.

An outside view should never be carelessly disregarded, and a little experiment sometimes nets big returns. I do not mean by this that much or any time should be wasted on the many wild-cat ideas that will reach you from time to time. You will have to use your

judgment. But in your discretion, do not offend. Rather encourage the efforts of others and develop in them the particular abilities they seem to possess. Thus you will hold their confidence and gain their cooperation, without which little can be accomplished. It is all a matter of judgment—and on this, you must either rise or fall.

Your father,

JOHN RUSSELL.

VI

Records which Control Production

IT is said that while the great Equitable Building was yet under construction in New York, all of its 2600 rooms were rented. The owners were able to sign leases for the rental to begin on a certain day, because they had a contract with the builders calling for completion of the work within 365 days. Should they fail to complete the building within that time, the builders agreed under their contract to pay a large money penalty for each extra day required. Since the rent totaled $3,000,000 a year, or $8219 a day, the owners felt justified in requiring this protection. No necessity for exacting penalties arose, however. The work was completed on the dot, the tenants took possession on the day agreed upon, and the owners began to receive income from the building exactly on the day they had set.

In the case of a product so large and costly as an office building it is easy to see how delay in production costs money. Until the building is actually produced—that is, completed—it renders no service to its owner; he

can make no use of it himself, nor can he rent it and thus get an income from it. All the money invested in the land upon which the building stands and in the steel, stone, concrete, and other materials used in construction, is idle—is returning no benefit. Moreover, taxes are being paid upon the land, with no resulting benefit. When the investment runs into millions of dollars—as was the case with the Equitable Building project—the loss mounts up rapidly to an enormous total which is reflected directly in the rent.

How Delay Runs up Costs

The costliness of delay is not so readily seen in the case of a factory producing an article of small unit-value. And yet, the conditions are essentially the same in both cases. The longer it takes the watch factory to make 10,000 watches, the higher is the cost of each watch. The labor may be paid for entirely on a piecerate basis, but all the other factors of expense are directly influenced by time consumed. First of all there is the money invested in steel, brass, nickel and other parts, just as in the case of the office building there was the money invested in stone, concrete and other material. The longer it takes to produce the watches, the longer the investment in material is tied up. Frequently it is borrowed money on which the factory is paying

a bank 6 per cent; and even if not borrowed, it is idle so long as it is awaiting turnover from material into salable goods. It is money that could be put in savings banks or into government bonds and made to earn a good interest with practically no risk at all! Therefore, every additional day it is idle pushes final costs up another notch.

Moreover, the money invested in equipment represents additional capital upon which interest or its equivalent must be reckoned for every unnecessary day spent in turning out the 10,000 watches. And taxes on the factory property and all other indirect expenses are piling up constantly. A simple analysis of the elements entering into the cost of production shows quickly that in any kind of production—whether it be the production of articles of small value, like shoe-laces, or of high value, like skyscrapers—any increase in the *time* spent upon production increases the cost. And the reverse is also true: *Any decrease in the time spent upon production decreases the cost of production.*

What the good factory man is constantly striving for is rapid turnover—by which is meant rapid conversion of raw material into finished goods, and of the finished goods into cash. Earlier chapters of this Unit have referred to this basic principle, and have shown

how labor and material records are used to speed up production. We are now to consider this problem from the viewpoint, not of any one element in costs, but of the production as a whole.

Rapid Turnover the Method of Good Production

When an order is received or a certain lot of production is authorized, the details of the undertaking are considered first by the authority which plans the work and lays it out. In a large machine shop this may be an engineering department of several experts. Just as the architect lays out the plan of the building, specifies the kind and quality of material to be used, and indicates other details to be followed by the builder, so the engineering department is the technical authority in a plant of this kind whose say-so is guiding in all questions as to methods to be followed, materials to be used, tools and machines to be used. After all fundamental questions have been settled, the details are turned over to the draftsman who makes the drawings from which blueprint copies are later furnished for the guidance of the mechanics.

From the engineering department, the work goes to the planning department. The special function of the planning department is to put into effect the instructions of the

engineering department, by laying out the work, routing and scheduling it through the various production departments. In some factories there is no engineering department, the planning department being the prime authority. And of course the exact organization varies with different plants, the planning department having additional functions in some plants, or its work being attended to by some other department or individual in other plants. The point is, some central authority must control the ordering of work through the factory if it is to move forward with the least delay and cost. And in the exercise of this control, certain records are necessary.

The Planning Department

Let us assume that the plant we are analyzing is a large machine shop which has an engineering department as well as a planning department. The work of the planning department begins only when the engineering department has finished its part of the work. Assume that it has furnished, through the draftsman, complete blueprints of the goods to be manufactured, including specification of the kind of material to be used and the operations to be performed. Then the planning department takes up the job of routing the work through the factory.

In doing this it is guided directly by its

records. Production orders of work already in process show just how each department or machine stands on the schedule, and indicates when and where the new work may be assigned. Moreover, production orders of previous jobs show how similar work has been handled and guides the planning experts in picking the right men to handle the present job. In all of this analyzing and planning, the department must work in close cooperaiton with the superintendent.

When everything is in readiness for manufacturing to begin, the order clerk in the planning department makes out a PRODUCTION ORDER for the new job. When O. K.'d by the superintendent, this goes to the producing departments and is their authority for taking up this new work. The production order gives all details of the job, lists the various operations to be performed and the departments that are to perform them, indicates the schedule which the work is to follow, and specifies rates to be paid for the various operations. A copy of this order is sent to the cost department and becomes a part of its records for determining the cost of the job.

The Production Order

Mention has been made in the chapter on "Labor Records" of the use of job tickets. *Job tickets* are issued on the basis of the

production order. The production order is the central and guiding record governing the production of the entire order, whereas a separate job ticket may be made out for each operation to be performed, or even for each workman.

Piecework Rate Cards

When the order calls for an entirely new product, special care is given to the supervision and study of the work as it proceeds in order that the one best way of performing each operation may be determined. Especially where the work is done on a piecerate basis, it becomes necessary to make time studies and establish standard time for performing each operation. In such cases a time-study expert is employed, and with a stop watch he times the various operations at the machine and at the workbench, records them carefully, and thus there are provided accurate data for fixing the rates to be paid, reckoning the time required, and the costs. After one job has been completed these figures are available for planning future jobs. A convenient form of record for conveying such information to the various operating departments is the PIECEWORK RATE CARD. It is both a rate card and a routing card, showing the order of work from department to department. Rates are extended so that each department gets only the piece-

rates covering its work. In the illustration, for example, rates are given only for the drill-press department, showing that this card is intended for that department.

Part Name..... **No.**.....

Where Used.....**Supersedes No.**.....

Opr. No.	OPERATION NAME	PRICE	
	SCREW DEPT.		
1	*Form, Drill, Turn and Cut Off*		
2	*Tapping*		
	LATHE DEPT.		
3	*Turning and Facing*		
4	*Finish Turn*		
5	*Face Two Sides Complete*		
	DRILL PRESS DEPT.		
6	*Mill*	1	00
7	*Lap and Burr*		70
8	*Dr. and Ctsk. Holes Rm. D.P. Hole*	1	00
9	*Tap Screw Hole*		20
	POLISHING DEPT.		
10	*Grain Polish One Side*		
	BLACKSMITH DEPT.		
11	*Blue*		
	LATHE DEPT.		
12	*Polish to Gauge*		
	ASSEMBLING DEPT. (Finished)		

Piecework Rate Card

Production orders are numbered consecutively, and jobs are referred to by their order numbers. All subsidiary records, such as job ticket, rate cards, and the like, are identified *with* their order by the order number. The

production order also refers to the drawing number, when blueprints are used, and the blueprints may accompany the order when it goes from the planning department to the various foremen.

In addition to production orders, there are SHOP ORDERS. These are orders for the manufacture of something to be used within the plant. Thus, a machine shop might make a certain number of tools for use in the shop. The order calling for the manufacture of tools would be a shop order. The production order applies only to manufacturing goods for sale, not for the factory's own use. Shop orders are assigned their own series of numbers, to avoid confusing them with production orders. Copies of the shop orders are sent to the cost department, and all tools or other supplies manufactured on shop orders are charged against the department or job in which they are to be used.

Shop Orders

The planning department keeps a carbon copy of each order issued, both production and shop orders, and as the work is completed and so reported to the planning department, it removes its copy to a "dead" file. Thus the orders in the live file show at any time the uncompleted work then under way in the factory.

After the production order has been issued, it is important to follow up the work and

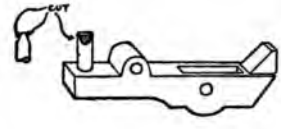
see that each part of the job is completed on scheduled time. The foreman in one depart-

PIECE WORK
INSTRUCTION CARD

NO.	DETAIL INSTRUCTIONS	FEED	SPEED		PREPARATION TIME	TIME WORK OUTSIDE CAGE
		AMOUNT	DIR.	R. P. M.	DIR.	
1	Pick up tote box and place on bench .10 X 1/300				.001	
2	Pick up piece, place in fixture and tighten					.080
3	Lever up					.020
4	MILL (Straddle)	hand		400		.040
5	Lever down					.015
6	Loosen and remove piece					.040
7	Gage .10 X 1/30				.003	
8	Grind and adjust cutter 10 X 1/1500				.006	
9	Remove finished work pail.10 X 1/300				.001	
					.011	.195
	.195 Handling time at 49%					.096
	Working cycle					.291
	.011 preparation time plus 25%					.014
						.305
	Allowance for washing up and oiling machine 2.5%					.008
						.313

man OPERATES 1 MACHINES OR
OPERATIONS #19 (GUN "D")

WHEN WORK CANNOT BE DONE AS SHOWN, REPORT MUST AT ONCE BE MADE TO THE MAN WHO SIGNED THIS CARD. DATE 11/12/18 SIGNED DVM



TIME PER UNIT 31.3
PREPARATION TIME 192
PIECES PER HOUR 100
UNIT
SIZE OF MATERIAL 3.5% Nickel Steel
OPERATION top
SEAR ENGINEERING
Straddle Handmill Bevel Right & Left Side on Bolt Stud & quality
T&W #2 Hand Miller
19

In factories where the work is carefully standardized, the planning department may issue an instruction card with each job which specifies how the work is to be done, the time required for each operation, the rate to be paid, and other information

ment must keep up with the production in the other departments. If he lags behind, *even in the* production of a small part, his

failure to keep up to schedule may delay the entire production. If he booms ahead and turns out work faster than the schedule calls for, he clogs up the stock room with surplus parts. Efficiency calls for evenness of production.

Keeping up to Schedule

In order to keep work up to schedule, the superintendent or foreman must know two things: (1) how much he is expected to produce within a given time, and (2) how much of it he has produced at the end of any day or week. Such information as this cannot be carried around in one's memory—certainly not in a plant of any size. A record is necessary, and here use may be made of some such arrangement as the progress charts illustrated in the second chapter of Unit III.

A complete and satisfactory scheme for keeping constant tabs on production was devised by an organization that manufactures phonographs and dictating machines. This plant comprises eighteen operating departments, employing about 3000 workmen, and it is easy to see that opportunities for confusion and delay would be numerous. One of the departments is called the automatic-machine department because of the type of machines used. Ten thousand different parts go into the making of the different models,

and about seven thousand of these are made in the automatic-machine department. All the parts made here are forwarded to the various other departments for further operations and assembling.

Take the case of the foreman of this automatic-machine department. He has under him one hundred and twenty-five men and about three hundred automatic and semi-automatic machines of a dozen different types. His problem is to keep all the men and machines busy, and in doing so to turn out each of the seven thousand parts in such evenly-balanced quantities that they will meet the scheduled requirements. The scheme used to control and guide this production is represented by the SCHEDULE BOARD illustrated in Figure 2.

Using the Schedule Board

This board is made by the planning department and kept up-to-date in the department in which it is used. Here is how it is done. The number of machines to be manufactured each month to supply the sales department with the output required for the year, is known. The number of each part going into each machine is also known, and from this it is a simple matter to figure the number of parts required for the total production. On the *basis of* this information a schedule board is

drawn up for the automatic-machine department, and similarly one is made for each of the other seventeen departments.

As indicated in the illustration, the schedule board shows the record for each part. In the first column the part number is given. In the second, the name of the part may be written. The third column shows the schedule per week, and the fourth the schedule per day—the number of each part that must be turned out weekly and daily if the production of all departments is to move along at an even rate. The figures shown in the third column are obtained by dividing the required output for the year by 52, the number of weeks; and the figures in the fourth column are obtained by dividing the number of working days per week into the weekly requirement.

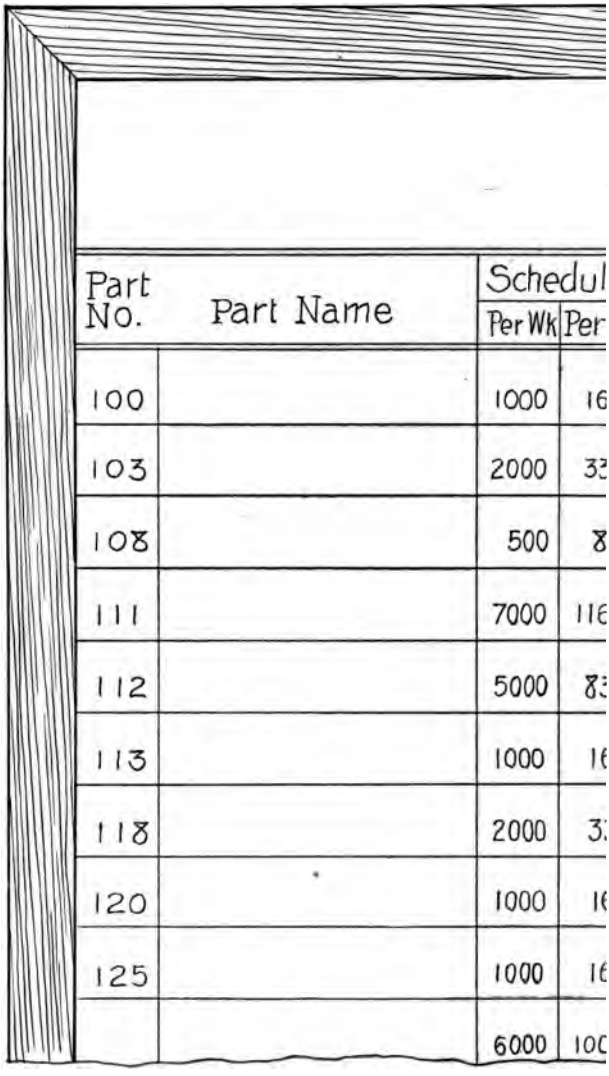
Following the schedule columns "per week" and "per day" are fifty-two spaces, each representing one week of the year. As the board comes to the automatic-machine department, or any other operating department, for use, these spaces are blank. Upon them the department will keep its own record of output, and by comparing output week by week or day by day with the schedule in columns 3 and 4, it can tell how well it is keeping up.

The record of output is kept by means of small metal tacks, whose heads are lettered in accordance with the various operations. Thus

Ⓐ indicates first operation
Ⓑ indicates second operation
Ⓒ indicates third operation
Ⓓ indicates final operation, regardless of whether it is first, second, or third
● indicates job held up on account of lack of material.

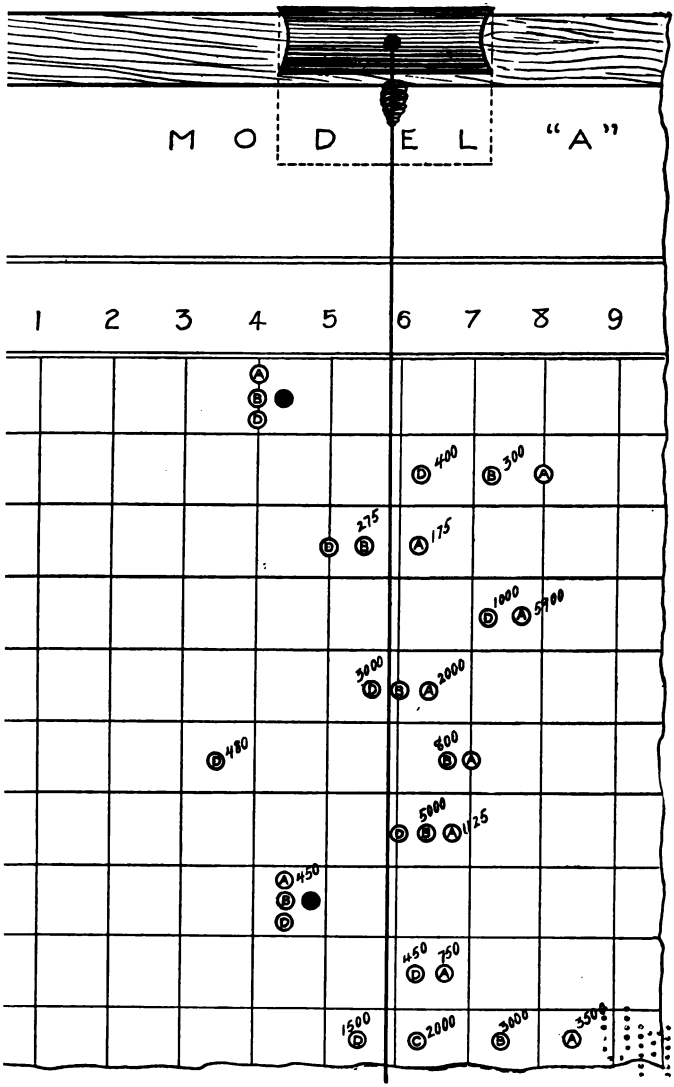
An even more effective scheme of designating the operations is to use a different colored tack, instead of a different letter, for each. Thus red might indicate the first operation, white the second, blue the third, and green the final. But whatever the scheme used, the tacks are placed on the board to indicate how much of the output of each part has been processed through each operation. As work in the department progresses, and job tickets are turned in to report the completion of various parcels of work, the clerk in charge of the schedule board advances the tacks to represent the present standing of output.

For example, let us assume that Part No. 103, Operation 2, has been finished to meet the schedule up to the fifth week. Since the weekly requirement is 2000, this means that *10,000 parts* have been finished through this



Part No.	Part Name	Schedul	
		Per Wk	Per
100		1000	16
103		2000	33
108		500	8
111		7000	116
112		5000	83
113		1000	16
118		2000	33
120		1000	16
125		1000	16
		6000	100

FIG. 2.—A CORNER



HE SCHEDULE BOARD

operation. A job ticket now comes through for 4300 parts, and Tack "B" is thereupon advanced to a position on the board just beyond the seventh line, since the production is 300 more than the production for seven weeks. (The figures written in by the side of the tacks indicate the production beyond what the line indicates.) Eight weeks' output of this part has been processed through the first operation, and 12,400 have passed through the final operations. *How the Board Works*

In Part No. 100 the record is not so encouraging. Four weeks' output, in this case 4000 parts, have been carried through all operations; but beyond that there has been no production of this part for the reason indicated by the black tack—lack of raw material. Of course this black tack becomes an immediate warning to the foreman, and the minute it appears on the board in any space he gets his requisition system working to obtain the necessary raw material.

An important feature of the schedule board is the wire indicator, which is moved forward each day to show just where production in all parts should stand on that day. By comparing the position of the tacks with the position of the wire, one can tell at a glance when production in any column is falling behind or pushing ahead.

Thus the schedule board is a graphic chart of the standing of production, itemized by parts and by operations. It is a picture of the factory's progress, or lack of progress, in any department. Not all factories require the degree of detail that the chart illustrated shows. Frequently it is necessary only to keep track of final operations.

A Picture of Production

Such a graphic record of production is not only a safeguard against overproduction or underproduction in any department, but it is also a factor in reducing costs. Under the old loose arrangements of former days, it was common to have men going through the departments to check up possible shortage or delay. The use of schedule boards reduces such use of stock-chasers to the minimum.

VII

Getting at the Cost

WHAT did it cost? This is the vital question to the head of every business, whether merchant or manufacturer. It determines his selling price, it guides his campaign against competitors, it affects his profit.

Guesswork here is poor business. A guess that is too low will undoubtedly result in large sales, but with resulting disaster to the finances of the concern. A guess that is too high will result in diminished sales, especially if the product has to meet the competition of similar products on which prices are more scientifically determined. The manufacturer or the merchant must *know,* not guess, if he is to guide his business successfully.

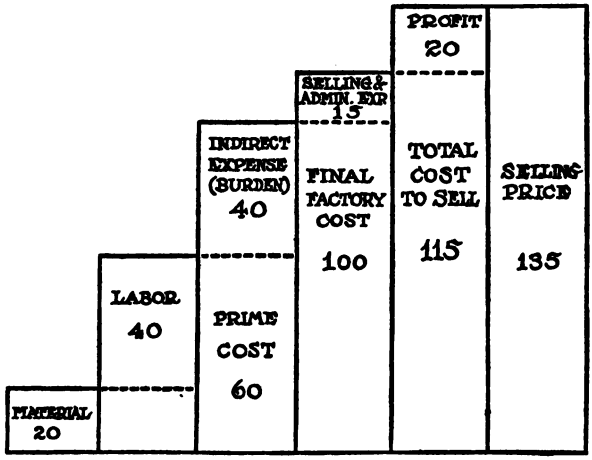
Guesswork is Dangerous

At first thought it may seem to be a simple matter to determine costs. The books show purchases, wages and salaries paid, and all items of expense. These are the total cost, and the cost of each article is simply a proportion of this total. But an accurate result cannot be arrived at so easily as that—espe-

cially where goods of varying character and value are dealt with, and more especially in the case of the manufacturer. His task of cost finding is even more difficult than the merchant's, because the manufacturer's costs are made up of such a variety of items and his processes of producing goods are so much more complex and difficult to keep detailed account of.

As an example, consider your watch. Before that product reached its present form, one hundred and ten separate parts had to be manufactured. And each of these parts passed through an average of six operations. The tiny second-hand required the labor of five workers in its production. After the individual parts had been manufactured, they had to be assembled—first into several small combinations, then these in turn had to be brought together in larger assemblies, until finally the watch ticked rhythmically a complete finished product. Where so many different materials and so many individual operations of labor enter into the cost, you can easily understand that guesswork is dangerous and that reckoning costs by totaling the material, wages, and other expenses of operation, is clumsy and misleading. The efficient manufacturer in every line wants to *know, not* only how much money he has had

to spend during the year in carrying on his manufacturing, but also this: the cost of producing each type of watch, or each type of automobile, or each grade of paint, or each weave of textile. In other words, he wants to know the per-unit cost.



Relation of Cost Elements to Selling Price

The ordinary system of bookkeeping is inadequate to give this information. To determine costs and keep account of them, a separate system of gathering and summarizing expense items is necessary. This use of records to determine costs is called *cost accounting,* and in all modern industrial organizations today is a vital part of the factory teamwork.

Cost Accounting

Cost accounting has three functions to perform, all distinct, though the others depend

upon the first-mentioned. (1) The first is that of determining the actual cost. (2) The second is that of controlling the cost elements so that they cannot be diverted, without detection, from the purpose for which they were intended. (3) The third function is that of supplying to the management each month or period a series of reports by which it may be able to measure the efficiency of the various producing departments and keep informed regarding the financial condition of the producing end.

Three Elements of Cost

What are the elements of cost—the items of which cost accounting must give accurate detailed records? The final manufacturing cost of any article consists of three elements: (1) direct material, (2) direct labor, (3) indirect expense. Indirect expense is also referred to as "overhead expense," or "burden." The first two, direct material and direct labor, when added together give the prime cost. Add to prime cost the indirect or overhead expense and you arrive at the final manufacturing cost.

Direct material and direct labor are so called because they enter directly into the article manufactured. The cost of the leather, canvas and eyelets, for example, are part of the direct material cost of shoes. The wages of the men who work upon these mate-

rials and turn them into shoes, are the direct labor cost.

Indirect or overhead is not so simple a matter. It is of three kinds:

1. Indirect material.
2. Indirect labor.
3. Expense.

Indirect material is that material which is used in the manufacture of a product but which does not actually enter into the product. The lubricating oil for the machines at which the shoe operatives work, is an example of indirect material. Labor incident to manufacturing which is not directly applied upon the article made, is indirect labor. The salaries of foremen and the wages of truckers, inspectors, and shop instructors, pay for indirect labor. Expense includes all other items of manufacturing expense, such as rent, light, heat, power, insurance and the like.

What Goes into Overhead

Indirect or overhead may be further classified as:

1. Departmental.
2. General operating.

Departmental indirect expense is that incurred in an operating department. For example, indirect materials such as oil, binding wire, emery cloth, and similar supplies, *indirect labor* such as the foreman's and other

department supervising salaries—all these are departmental indirect expense.

General operating expense is of a somewhat different nature. It is an expense created for the benefit of all the departments, but which cannot be charged directly to any particular one. The general superintendent's salary, salaries of the planning department, also those of the watchmen and janitors, besides taxes, building repairs, and the cost of maintaining the welfare and employment departments, are items of general operating expense.

When a plant is operating on a departmental basis, after each department has been charged with everything that goes to make up its departmental indirect expense, it is in addition charged with a certain proportion of all the general operating indirect expense. These two combined constitute the entire indirect expense or overhead which must be disposed of by being absorbed into the cost of the finished article through an equitable method of distribution. Methods of overhead distribution will be considered later in this chapter.

There are several systems of cost accounting, varying according to the type of manufacturing whose costs are to be recorded. Perhaps the three most commonly used systems are:

1. Special order system.
2. Standardized part system.
3. Product system.

Under the SPECIAL ORDER SYSTEM all items of cost, including a proper proportion of the indirect expenses, are charged directly to the order. This system may be used in accounting the manufacturing cost of locomotives, steamships, expensive jewelry, motor trucks, made-to-order furniture, and the like.

The Special Order System

Assume that five motor trucks of a specified type are being put through the factory, either for stock or to meet a particular customer's order already received. A production order would be issued as explained in the preceding chapter. This order would bear an order number. As material is used, whether from the store room or purchased expressly for this order, and as labor is applied, the costs are charged against this order number. These costs are accumulated from different sources. Material costs would be compiled from the numerous material requisitions or purchase requisitions, all of which show the number of the order to which the materials delivered are to be applied. Labor costs would be gathered from the time checks or job tickets of the workmen. Adding to these a proper proportion of the indirect expense gives the final manufacturing cost.

Standardized Part System

The STANDARDIZED PART SYSTEM provides for the application of all costs to the individual part entering into the completed article. In this system the charges are made against a part number rather than an order number. Take, for example, a watch factory in which more than five hundred operations are involved in making a watch. As is the case in many other factories, the workmen are specialized, one concentrating on one operation and doing nothing but that, while others specialize on other operations. Records are kept of the direct labor spent in each operation. Each part is given a "part number." There are standard operations for every part, numbered consecutively in the order of their performance. One workman, engaged in cutting a groove in a certain part of the watch mechanism, is given, let us say, 10,000 parts to put through this operation of grooving. When the work is given to him the time-keeper notes the time; it may take him four hours or eight hours or two days to groove the 10,000 parts, according to the difficulty of the operation; whatever the time required, it is noted by the time-keeper when the worker returns the grooved parts. Then it is a simple matter for the cost accountant to reckon the cost per *hundred* or per thousand for that operation,

by dividing the number of parts into the total labor cost of putting the entire lot through the operation.

In a similar manner the lot passes from workman to workman until all the operations have been completed and each part becomes a finished part. The cost per hundred or per thousand for each operation is then a matter of record. The cost of materials is kept account of by a system of requisitions. Taking first the cost of the raw materials and adding the cost of all operations on a particular part, the result arrived at is the material and labor cost for that part.

In like manner two or more parts are brought together into what is known as an assembly. The cost of this assembly consists of the cost of the two single parts plus the cost of bringing them together. Minor assemblies find their way into larger ones, which in turn progress until the finished watch is reached. Costs are built up in exactly the same way as the watch. When the watch is completed the cost is known.

Only where production is turned out in large quantities, and where the manufacturing is conducted on a schedule of standardized operations and parts, can this system be employed. Airplanes, guns, phonographs, typewriters, watches are products to which this

system may be applied successfully. In this day of vast production, under methods of standardization of manufacturing, this system in all its refinements is of unlimited benefit in determining costs of every operation, every part, every assembly or combination of assemblies, terminating in the exact cost of the completed article. At the same time it makes possible such comparisons with previous performances as to safeguard against excess of waste, scrap, defective parts, or other leaks.

The Product System

The PRODUCT SYSTEM fixes costs on the process, rather than on the part or the order. It is adapted to special types of manufacturing, such as paint factories, canneries, bakeries, foundries, chemical plants, and the like. In the case of a baking plant, all costs for a particular dough would be charged to the process. The total cost of the entire product is thus obtained. The number of loaves made divided into the total cost gives the cost per loaf. In a foundry, all costs for a given period are applied to the product manufactured. Dividing the weight of completed castings into the total cost gives the cost per ton. Statistical figures may also be compiled showing the cost per ton for melted metal, labor cost, melting-department overhead, and overhead other than melting. *Undue variations* in the cost of the completed

castings per ton may then be traced to their source.

From the foregoing it must not be thought that any factory can satisfy its cost-accounting requirements by selecting some one system. It is not unusual to find all three systems at work in a single plant. Take, for example, a large automobile factory. It makes a standard car in great quantity, manufacturing all parts including the motor and castings. It makes two regular types of bodies, roadster and touring, also in large quantities. In addition, the factory has a separate department for the manufacture of bodies of special designs on special orders from customers.

The System Must Meet Every Condition

Ask the works accountant in this factory, "What kind of cost system do you use?" He will tell you that his system is a combination of three systems, each of which meets special requirements. Here is how the combination works:

Much of the manufacturing consists of making large quantities of standardized parts, and for the departments in which this work goes on the cost accounting is according to the standardized part system. In the foundry, however, the product system is used. This system is used also in the nickel-plating department, where many different parts enter

the bath at the same time; after the cost of the mass has been determined, the cost per hundred of each kind of part nickled is determined according to a schedule based upon the relation of surface area covered. From the plating bath the parts are forwarded to the final assembling department, where the standardized part system is operative. The third system is used in the special-body department. Here all work is done on special production orders, and since here there is ever changing variation in the designs and materials used, the special order system is applied.

The necessity of applying cost principles to fit actual manufacturing conditions *can not be overestimated.* Each plant presents its own problems, and the cost system must be built to take care of these.

In cost finding, the most difficult task perhaps is that of making a correct distribution of the indirect expenses. In the discussion of the three systems described no mention was made of the overhead. This item is generally considered a special problem, and various methods of handling it have been devised. Perhaps the two most approved methods of distributing overhead are:

Distributing the Overhead

1. The direct labor method.
2. The machine rate method.

When the indirect expense is to be disposed of according to the direct labor method, the manufacturing conditions should first be thoroughly analyzed to determine which basis of distribution will bring to each job a proper proportion: (1) the basis of direct labor *cost,* or (2) that of direct labor *hours.*

As an example of distribution on *direct labor cost,* let us observe the finishing department of a plant manufacturing safety razors. The operators are paid on the time basis, forty cents an hour, all being paid at about the same rate. Little machinery is required. There are one hundred operators and they earn on an average of $25 a week. The weekly payroll for direct labor amounts to $2500 weekly, or about $10,000 a month. The indirect expense is approximately $7500, this including both the departmental indirect expenses and the general operating indirect expenses. Tabulating the two items, we get this result:

Direct Labor Cost Method of Distribution

Direct Labor.....	$10,000
Indirect Expenses..	7,500

Thus, for each $1 spent for direct labor 75 cents must be added for overhead, making a total assembling cost of $1.75. Assume that *John Smith* assembles fifteen razors an hour,

while Henry Jones assembles thirty. Each is paid forty cents, and adding the overhead at the rate of 75 per cent shows a cost of seventy cents for Smith's lot of fifteen, while Jones' lot of thirty cost also seventy cents, or half as much per razor as those turned out by Smith. Though it may seem illogical that thirty should cost the same as fifteen, you need only to analyze the situation to see that this is true, and that the overhead is properly distributed. Take the direct labor; there can be no doubt that twice as much is paid for one lot as the other. Take the item of overhead; each man uses the same amount of floor space, the same amount of light and heat, and requires equal supervision; you cannot fairly charge more overhead against the lot of thirty than against the lot of fifteen. Through keeping record of the production of each workman the management soon learns that either Smith is overpaid or Jones underpaid.

Such a system of distribution will not work under all conditions, however. Suppose that Smith receives only twenty cents per hour while Jones gets forty cents. In this case the direct labor for assembling each lot of razors is equalized; twenty cents for the *fifteen,* forty cents for the thirty. Apply the

Direct Labor Hours Method of Distribution

overhead on the basis of direct labor cost as before: 75 per cent on twenty cents, or fifteen cents, is Smith's share; 75 per cent on forty cents, or thirty cents, is Jones' share. This gives us an assembling cost of thirty-five cents for the fifteen razors, and seventy cents for the thirty, or the same cost each. But this is wrong, for Smith occupies just as much space and calls for just as much overhead in his hour as Jones does; yet the overhead in one case is fifteen cents, in the other thirty.

To guard against such inequality, overhead is distributed on the basis of direct labor hours. Under this scheme, the total overhead—in this case, $7500—is divided by the total number of labor hours for the period. Assume that the number of hours for which wages are paid are 25,000; this divided into $7500 gives an overhead cost per hour of thirty cents. Under this method of distribution, Smith's share would be the same as Jones', notwithstanding the difference in their pay. The lot of fifteen razors would then cost for assembling: direct labor, twenty cents; overhead, thirty cents; total, fifty cents, or three and a half cents each. The lot of thirty razors would then cost for assembling—direct labor, forty cents; overhead, thirty cents, total, seventy cents, or two and a third cents each.

(1) *Where there is a uniformity of production, operations, equipment and wage scale, the indirect expenses may be distributed on a basis of direct labor cost.*

(2) *Where there is a difference in the production operations and in the wage rate, or where a piecerate system of wages is used, indirect expenses are more accurately distributed on the basis of direct labor hours.*

The Machine Rate Method

Under the machine rate method all indirect expenses are applied to the machines used in production, and thence apportioned to the product according to the length of time a machine is in operation. It is customary to sort the machines into classes according to their value, floor space, power cost of operation, depreciation. Ten machines might be in one class, while again one machine might stand in a class by itself. Under a highly refined plan of the machine rate method, all charges possible are allocated directly to the machines. For example, it is possible to keep exact records of the amount of lubricating oil, repair parts, and other incidentals used at each machine within a given period. Where each machine has its individual electric motor, it is a simple matter to keep account of the power used. The floor-space occupied by the *machine* furnishes a basis for figuring the

proportion of taxes or rent, and insurance, which should be charged to it.

When all possible charges which can thus be identified with the machines have been applied, there remains some expenses which are yet undistributed—such as light, heat, expenses of supervision. These are totaled and a distribution made among the several classes of machines in such proportions as the conditions indicate as fair. When the total cost of machine operation for a certain period has been determined, it yet remains to ascertain the number of hours the machine was in operation during the same period. For example, suppose that apart from direct labor a certain machine involved total expenses of $479 during a given week. The records show that the machine was in actual operation 47 hours during that week. Dividing this into the machine cost we arrive at the machine rate or machine-hour cost—in this case $10.21.

Whether the distribution of indirect expenses should be made upon the basis of direct labor or machine cost depends entirely upon the manufacturing conditions. The manufacturer in each case must study the conditions existing in his own plant and apply that system which gives the most equitable distribution.

Sometimes you will find a factory which

keeps practically no cost records and fixes its selling price on a purely estimating basis.

The Estimating Cost Plan

When it has the finished article in hand it will estimate the cost of material and the labor expended, add to this a fixed percentage for overhead, and the figure so computed will be accepted as the cost. Where material is the principal factor in costs, as is the case in the manufacture of jewelry, records of material cost may be kept, and the final cost determined by adding some given percentage to this to cover labor and overhead. Of course, such methods are loose and inadequate. And while a profit may be made on the total business of the year, it is likely that many of the articles are sold at a loss. Confronted by this situation, as profits become less and losses are in sight, the manufacturer will call in a cost accountant to verify the cost estimates. A simple system for doing this, known as *plan for verifying estimated costs,* has been devised.

To explain the plan let us take a small factory manufacturing raincoats. Four grades are made, the costs have been estimated as follows:

	Materials.	Labor.	Overhead.	Total Estimated Cost.
Grade A...	$6.00	$4.00	$2.00	$12.00
" B...	4.50	3.00	1.50	9.00
" C...	3.00	2.50	1.10	6.60
" D...	2.00	1.75	.75	4.50

The plan calls for a periodical testing of the accuracy of each element of cost as estimated, say every year or half-year. As a result of these tests the schedule is revised from time to time so that the estimates for the following period may be more nearly correct.

In order to make the tests, separate material accounts are kept for each grade, each being charged with the particular material bought for that grade of raincoat. Likewise the labor spent on each grade is kept record of. At the end of the year it is possible to determine just how much has actually been expended for material and labor on each grade. Dividing these figures by the quantity produced, the correct material and labor cost for each is found. To complete the verification it is then necessary to determine what rate of overhead must be added to equal the actual indirect expenses incurred during the year.

The usefulness of a plan of this kind is very limited. A year, or even six months, is a long time to wait to determine whether operations are being conducted on a profitable or losing basis. And conditions during the year may change entirely, so gradually perhaps that they are scarcely noticed at the time, yet so considerable in their accumulation as to render the estimate worthless.

And of course such a plan is very inadequate as a means of testing the efficiency of the workmen or the management; no detail records are maintained through which comparisons with standards or past performances may be made.

Cost System Must be Adapted to the Special Needs of the Industry

A cost system which is comprehensive, accurate, and adapted to the needs of the business is an essential to all successful manufacturing. Sometimes a manufacturer hesitates because of the expense of installing and operating a cost system. He will remark that "such luxuries are only for the big fellows." Of course his point of view is wrong. The cost system in every case must be made like a tool or machine to fit the particular conditions under which it is to work. Elaborate checking systems, complex files and records, a force of many employees may be needed in a plant employing 10,000 workmen, but that does not mean that the same force and equipment is needed for a plant of 500 or 100 workmen. Both the country store and Wanamaker's require the services of salesmen—but that does not mean that the country store and the big department store must have the same kind and size of organization. So with cost systems. They vary according to the size, char-

acter, output, and other conditions of the plants they serve. And far from being a luxury, many a plant, both small and big, has found its cost system to be a life-saver—an essential of the highest kind.

In the following chapter the working of a typical cost system will be indicated.

VIII

A Cost Accounting System in Operation

WHILE cost accounting is an activity largely separate from that of the general accounting or bookkeeping department of the business, its system of records makes use of many of the features of commercial bookkeeping.

One of these is the practise of creating an account for each item of income or outgo, and personifying this account. When John Smith buys $10 worth of goods on credit from a merchant, the merchant charges the account (or record) of John Smith on his books with $10. When John Smith pays, his account is credited with the amount of the payment, which is thereby subtracted from the amount of his charge. Thus, by its system of charges and credits (or, to use the parlance of bookkeeping, *debits* and *credits*), the books give a complete record of Smith's dealings with the store. In the same way, the factory opens accounts on its books with Coal, Steel, Lubricating Oil, Payroll, Taxes, Insurance, and all items involved in carrying on production.

Debiting and Crediting the Account

Also, accounts are opened with the various production orders or jobs. As additions are made to these accounts, corresponding charges or debits are entered against the account. For example, if 1000 tons of steel are purchased, the account Steel is charged with 1000 tons at the specified price. The Steel has received that much, just as in the case of John Smith he had received $10 worth of goods. If ten tons of this steel is requisitioned for use in filling Production Order No. 127, the account Steel is credited with the ten tons (just as John Smith is credited when he pays something on his account) and the account Production Order No. 127 is charged with the steel.

The rule is simple: Whatever account received a benefit is charged (*debited*) with the money cost of what it receives. Whatever account gives a benefit is *credited* with the money cost of what it gives.

The Ledger is a Classified Record

These accounts are kept in a ledger. A ledger is simply a classified record of accounts. It may take the form of a ponderous book, such as the old-time bookkeeper worked with, each account having its separate page or series of pages. Today the ledger is usually in the form of a compact loose-leaf book; or, more modern yet, a classified series of cards. In

a modern business organization, there may be several ledgers, each representing various groupings of accounts. Thus, there may be a sales ledger, a factory ledger, and several subdivisions of these into specialized ledgers. Always there is one general controlling ledger which summarizes all accounts, and from which it is possible to tell in short order the financial condition of the business.

The cost accounting system which will be discussed in this chapter is in use in a large American watch factory, a thoroughly modern plant which employs a force of two thousand workmen. The plant is divided into eighteen operating departments, and the cost system has been devised to follow the manufacturing at every step. Each department is a complete unit in itself, and is so recognized in the factory ledger.

Accounting for Raw Material and Supplies

As raw material and supplies are received at the plant and placed in the store room, the amounts of these purchases are charged in the factory ledger to the account Material and Supply. The details of all items included in this account are carried in a separate card ledger, the material-and-supply ledger, which corresponds to the perpetual inventory described in Chapter IV. Thus, as new purchases are received, they are entered both in

the general account for material and supply in the factory ledger and in the accounts itemized according to character of the material in the specialized material-and-supply ledger. As goods are drawn from stores the appropriate accounts in both ledgers are credited with the amount withdrawn; corresponding charges are made against those accounts representing the interests which receive the withdrawn material.

Goods leaving the store room are of two classes:

1. *Raw material.* This is charged in two accounts: (*a*) In the factory ledger to the Work-in-Process account; (*b*) In the work-in-process ledger to the watch-part account for which the material is requisitioned.

2. *Manufacturing supplies.* This is charged in the factory ledger to the manufacturing expenses of the department requisitioning the supplies.

The first named, the raw material, after it enters the production department becomes "work-in-process"; the second, manufacturing supplies, becomes "manufacturing expense." These two accounts are the controlling accounts in the factory ledger for all material and supplies issued from the store room.

Accounting for Indirect Expense

It is a part of the system in the watch

factory to strike a balance at the end of each four-weeks' period. The work-in-process account in the factory ledger then shows collectively the investment in work-in-process at that time, and by referring to the separate account cards in the work-in-process ledger it is easy to determine exactly how this investment is distributed among the various pieces or watch parts then in course of manufacture. Thus, as raw material works its way into work-in-process it becomes the first cost upon the individual watch parts into which it goes. And by means of the system of accounts in the factory ledger and in the work-in-process ledger, a progressive record is kept of this material as it passes from the raw state into the finished product.

Accounting for Direct Labor

In the same way, the cost of direct labor is attached directly to the production upon which it is applied. Earlier chapters have explained the system of job tickets and other time records of labor. As these are received by the cost department from the various operating departments, it is easy to post these charges against the particular watch part receiving the benefit of this labor. Labor is charged on the factory ledger to the Payroll account; on the work-*in-process* ledger to the account of the par-

ticular watch part or assembly upon which it is employed.

In all departments but one, the standardized part system of cost accounting is used. The exception is the gold-plating department, where the product system is used.

Several methods of distributing the indirect or overhead expense are used. There is one central controlling account in the factory ledger, the Manufacturing Expense account, to which all items of indirect expense are charged. It will be remembered that manufacturing supplies, as they are issued from the store room, are charged to this account (as explained on page 3). This account, Manufacturing Expense, not only shows the total overhead for the entire plant, but it is so itemized as to show how this expense is distributed among the eighteen separate operating departments.

How Overhead Is Distributed

The general operating expense of the plant —such items as salaries of the general manager and superintendent, operating expenses of the general offices, and the like—are distributed among the operating departments on the basis of number of employees in each department. Departmental overhead—such as foremen's salaries, inspection, and the like—is already identified with its own department.

But there remains the task of distributing

the total overhead charged to each department so that it will weigh fairly upon the production of those departments. Here it was found necessary to consider the individual requirements of each department, and as a result you find various methods in use. In six departments, the overhead is distributed on the basis of direct labor costs; in ten departments, on the basis of direct labor hours; in two departments the machine-rate method is used, all indirect expenses being applied to the machines, and distribution made on the basis of machine hours.

The Cost Record a Living Story of the Production

Thus, as a watch part passes through the various processes of manufacture and assembly, various charges are entered against it in the work-in-process account in the factory ledger and in its own individual account in the work-in-process ledger. The first charge is for material, and as this entry is made against its account, a corresponding credit is made in the material and supply account. As labor is expended upon the material, changing it into the finished part, additional charges are made against the watch part's account to care for this additional outlay; the payroll account in the factory ledger being credited with a corresponding amount. *At the same* time that labor is posted in

the ledger account, the overhead is also posted.

At the close of each four weeks' period the total of the overhead applied to the work-in-process in each department is credited to, and therefore deducted from, the manufacturing expense account for that department. In this way, it is known exactly how the indirect expense of a department is being applied to production. The departmental overhead is at all times under control, and any item may be traced back to its source at any time.

From the foregoing discussion it is clear how raw material cost is charged against the part into which it goes, and also how the direct labor and the overhead are posted in turn to the various operations through which the part is put. On an average, each part must pass through six operations, and the number of parts necessary to make the watch is more than one hundred. Each part is made in lots of several hundred or several thousand at a time, and while the cost records are posted on the basis of the lot, it is a simple matter of arithmetic to find the cost per separate part.

Getting at Per-Unit Cost

For example, suppose the part is a tiny cog wheel which requires ten operations to change it from raw material into a finished cog wheel. Assume that material is issued to

make a lot of five thousand wheels. The first charge will be for the material. Then, as the material passes through its first operation, a charge for direct labor and for overhead will be made to cover the total cost of its processing here. This will be charge No. 2. And so, with each operation. At the completion of the ten operations, the cost records will show the total cost of producing the 5000 cog wheels. Perhaps, when the final output is turned in, there are 4500 parts, 500 having been spoiled in process. This information will of course be entered upon the cost records, both to explain the shortage and to guide future planning of work. From the cost of producing 4500 cog wheels, it is a matter of simple division to determine the cost of producing a single cog wheel. The same method is followed with each of the other parts, and the labor and overhead expended in assembling the parts are likewise recorded in exact detail. Thus by adding together the per-unit cost of the more than a hundred parts, and the cost of assembling the parts, the cost department arrives at the cost of each watch.

The prime object of this cost system is to show exactly what it costs to produce each style of watch put out by this company, and *thus provide* an exact basis for fixing the

selling price of the watches. In this, the system is highly successful. There is never any guesswork in that company as to what its production is costing, for any rise in cost is indicated immediately.

But the value of the system to its company goes far beyond this primary object. It not only shows when increases occur, and thus guides the company in adjusting its selling prices, but it also shows *where* the increases are. The fact that the records are itemized as to each part and each operation upon each part, makes it possible to see just where the increased cost comes in. If, for example, the cost records of a certain period show that the cog wheel mentioned on the preceding page is costing more to make than it cost last period, while the other parts show no corresponding increase in cost, the attention of the management will be attracted directly to the work records of the men making this part. The reasons for the increased cost will be very carefully looked into, and if a leak is found it will be promptly repaired.

Cost Records as a Guide

Thus, the cost records not only guide the sales department in its activities, but they also guide the production department. They promptly betray any inefficiency in the operating departments, any looseness in the supervision or inspection, and point the ac-

cusing finger at the particular part or operation or person or department responsible. The cost records are able to do this because they answer practically every question that one might ask about the subject they are reporting on.

For example, take a watch which costs $12 to produce. How much of this cost is indirect expense? How much of the indirect is due to idle time? How much of the cost represents spoiled work? Which operations are costing more than they did last year, and why? What is the proportion of indirect labor to direct labor, and how does it compare with previous showings? How do the items that enter into overhead in each department compare with similar items for the previous period? Is their increase or decrease consistent with the greater or lesser amount of production turned out?

From the cost records of the watch manufacturer you can get a prompt answer to all of these questions. In fact, the cost department doesn't wait to be asked such questions but periodically draws up a cost sheet and other statements showing in detail how the costs of production are itemized and how these items compare with previous records. Such *statements* become chart and compass to the

The Ultimate Production Records

business. The manufacturer always knows "where he is at." If any line or style of product is losing, he knows it, and can act accordingly. If any line is earning an exceptional profit, he knows that; and has a basis for cutting prices or increasing his advertising and sales campaign. If any department is lagging behind, is costing more than conditions warrant, he knows it; and can proceed to reorganize the department in accordance with its needs. If any department or individual is making an especially fine showing, the manufacturer sees it in the cost records; and thus has an exact basis for recognizing exceptional ability.

Thus, cost records may be called the ultimate production records. All other production records—labor records, material records, equipment records, and the like—are essential elements of a good cost system. But they are only disjointed elements until they are brought together in a comprehensive system of cost accounting. It is such systems as this described for the watch factory that give modern production its central control upon all the elements entering into manufacturing, and make possible the amazing achievements of American industry in big-scale low-price production.

QUIZ QUESTIONS

I

1. Give two reasons why it is better to depend on records rather than on the memory for keeping business data.
2. How do records help in planning a job?
3. What advantage is there in centralizing the records of a concern under the control of one executive?
4. What simple rule is given for determining what records should be kept?
5. Name six factors in the plant of which the record system should keep account.
6. What four cardinal principles should be observed in planning and installing record systems?

II

7. How does tardiness in beginning work affect overhead expense?
8. Explain three systems of keeping account of the arrival and departure of employees.
9. What advantages are found in the use of time-recording clocks?
10. Where in the plant should the time-recording clock be placed?
11. Why is it important that the management know, not only the amount of time spent in the plant by the employee, but also the amount of time spent upon each job or assignment?
12. What criticism would you make of the method of having the employee report orally to a timekeeper regarding his time spent on a job?
13. What criticism would you make of the method of having the employee make a written report regarding his time spent on a job?

14. Why is it best to take the responsibility for keeping records of his use of worktime out of the hands of the workman?

15. What is the job-ticket system? Explain its operation.

16. Explain how the use of job tickets and scheduling of work eliminates waste time between jobs.

17. Explain the work-wanted-card system discussed in the chapter.

18. How is it true that time records are an advantage and help not only to the management but also to the men themselves?

III

19. What are the functions of the purchasing agent?

20. What is a "purchase requisition," and what information does it contain?

21. What is a "source of supply card"? What information does it contain?

22. What is a "request for estimate"? When is it used?

23. Under what conditions is testing necessary to right purchasing?

24. What is a "purchase order"? Explain the triplicate system of purchase orders discussed in the chapter.

25. What is a "perpetual inventory"? How does the use of a perpetual inventory reduce the amount of emergency purchasing?

IV

26. Explain the comparison of the factory stores-room with the commercial bank.

27. What is a "material requisition"? How does a requisition system safeguard material in the stores-room?

28. How is material in the hands of workmen safeguarded? Explain the system which uses the job ticket *as a check against* the requisition. Explain the system of *budgeting materials.*